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ABSTRACT

This consortium-developed instructor's manual for small engine repair (with focus on outboard motors) consists of the following nine instructional units: electrical remote control assembly, mechanical remote control assembly, tilt assemblies, exhaust housing, propeller and trim tabs, cooling system, mechanical gearcase, electrical gearcase, and fuel supply systems. Each instructional unit includes performance objectives, suggested activities for teacher and students, information sheets, assignment sheets, job sheets, tests, and answers to the tests. Many of the units include visual aids. (BM)

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OUTBOARD REPAIR

by
Jack Hardway

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FOREWORD

The Mid-America Vocational Curriculum Consortium (MAVCC) was organized for the purpose of developing instructional material for the twelve member states. Priorities for developing MAVCC material are determined annually based on the needs as identified by all member states. One of the first priorities identified was comprehensive small engine repair. This publication is a part of a project designed to provide the needed instructional material for small engine repair programs.

The success of this publication is due, in large part, to the capabilities of the personnel who worked with its development. The technical writers have numerous years of industry as well as teaching experience. Assisting them in their efforts were representatives of each of the member states who brought with them technical expertise and the experience related to the classroom and to the trade. To assure that the materials would parallel the industry environment and be accepted as a transportable basic teaching tool, organizations and industry representives were involved in the developmental phases of the manual. Appreciation is extended to them for their valuable contributions to the manual.

This publication is designed to assist teachers in improving instruction. As these publications are used, it is hoped that the student performance will improve and that students will be better able to assume a role in their chosen occupation, small engine repair.

Instructional materials in this publication are written in terms of student performance using measurable objectives. This is an innovative approach to teaching that accents and augments the teaching/learning process. Criterion referenced evaluation instruments are provided for uniform measurement of student progress. In addition to evaluating recall information, teachers are encouraged to evaluate the other areas including process and product as indicated at the end of each instructional unit.

It is the sincere belief of the MAVCC personnel and all those members who served on the committees that this publication will allow the students to become better prepared and more effective members of the work force.

Don Eshelby, Chairman
Board of Directors
Mid-America Vocational
Curriculum Consortium

PREFACE

For many years those responsible for teaching small engine repair have felt a need for instructional materials to use in this area. A team of teachers, industry representatives, and trade and industrial education staff members accepted this challenge and have produced manuals which will meet the needs of many types of courses where students are expected to become proficient in the area of small engine repair. The MAVCC Outboard Repair publication is designed to supplement the MAVCC Comprehensive Small Engine Repair publication by covering in detail all aspects of outboard mechanics not included in general engine repair or the repair of other small engines.

Every effort has been made to make this publication basic, readable, and by all means usable. Three vital parts of instruction have been intentionally omitted from this publication: motivation, personalization, and localization. These areas are left to the individual instructors and the instructors should capitalize on them. Only then will this publication really become a vital part of the teaching-learning process.

In addition, we would appreciate your help. We check for content quality, spelling, and typographical errors many times in the development of a manual. It is still possible, however, for an error to show up in a publication.

If, in the use of this publication, you should find something questionable we would appreciate you bringing it to our attention. A copy of the page or pages in question with your suggestions for correction would certainly help us when we revise and update materials.

We're trying to provide you with the best possible curriculum materials and will certainly appreciate your help in detecting areas where possible corrections are needed to maintain the quality you want and deserve.

Ann Benson
Executive Director
Mid-America Vocational Curriculum
Consortium, Inc.

ACKNOWLEDGMENTS

Appreciation is extended to those individuals who contributed their time and talents to the development of *Outboard Repair.*

The contents of this publication were planned and reviewed by:

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Special thanks are extended to Amon Herd, Director, Instructional Materials Laboratory, University of Missouri - Cloumbia and his staff for their contributions toward the development of this book.

Gratitude is expressed to Regina Decker and Mary Kellum for editing and to the Graphics Division of the Oklahoma State Department of Vocational and Technical Education for typing.

Special appreciation goes to Dan Stapleton for the illustrations and drawings used in this publication.

The printing staff of the Oklahoma State Department of Vocational and Technical Education are deserving of much credit for printing this publication.

USE OF THIS PUBLICATION

Instructional Units

The *Outboard Repair* curriculum includes nine units. Each instructional unit includes some or all of the basic components of a unit of instruction: performance objectives, suggested activities for teacher and students, information sheets, assignment sheets, job sheets, visual aids, tests, and answers to the test. Units are planned for more than one lesson or class period of instruction.

Careful study of each instructional unit by the teacher will help to determine:

A. The amount of material that can be covered in each class period.
B. The skills which must be demonstrated.
    1. Supplies needed
    2. Equipment needed
    3. Amount of practice needed
    4. Amount of class time needed for demonstrations
C. Supplementary materials such as pamphlets or filmstrips that must be ordered.
D. Resource people that must be contacted.

Objectives

Each unit of instruction is based on performance objectives. These objectives state the goals of the course thus providing a sense of direction and accomplishment for the student.

Performance objectives are stated in two forms: unit objectives, stating the subject matter to be covered in a unit of instruction and specific objectives, stating the student performance necessary to reach the unit objective.

Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the intent of the objectives. A limited number of performance terms have been used in the objectives for this curriculum to assist in promoting the effectiveness of the communication among all individuals using the materials.

Following is a list of performance terms and their synonyms which may have been used in this material:

Name	Identify	Describe
Label	Select	Define
List in writing	Mark	Discuss in writing
List orally	Point out	Discuss orally
Letter	Pick out	Interpret
Record	Choose	Tell how
Repeat	Locate	Tell what
Give		Explain

Order	Distinguish	Construct
Arrange	Discriminate	Draw
Sequence		Make
List in order		Build
Classify		Design
Divide		Formulate
Isolate		Reproduce
Sort		Transcribe
		Reduce
		Increase
		Figure

Demonstrate	Additional Terms Used	
Show your work	Evaluate	Prepare
Show procedure	Complete	Make
Perform an experiment	Analyze	Read
Perform the steps	Calculate	Tell
Operate	Estimate	Teach
Remove	Plan	Converse
Replace	Observe	Lead
Turn off/on	Compare	State
(Dis) assemble	Determine	Write
(Dis) connect	Perform	

Reading of the objectives by the student should be followed by a class discussion to answer any questions concerning performance requirements for each instruction unit.

Teachers should feel free to add objectives which will fit the material to the needs of the students and community. When teachers add objectives, they should remember to supply the needed information, assignment and/or job sheets, and criterion tests.

Suggested Activities

Each unit of instruction has a suggested activities sheet outlining steps to follow in accomplishing specific objectives. The activities are listed according to whether they are the responsibility of the instructor or the student.

Instructor: Duties of the instructor will vary according to the particular unit; however, for best use of the material they should include the following: provide students with objective sheet, information sheet, assignment sheets, and job sheets; preview filmstrips, make transparencies, and arrange for resource materials and people; discuss unit and specific objectives and information sheet; give test. Teachers are encouraged to use any additional instructional activities and teaching methods to aid students in accomplishing the objectives.

Students: Student activities are listed which will help the student to achieve the objectives for the unit.

Information Sheets

Information sheets provide content essential for meeting the cognitive (knowledge) objectives of the unit. The teacher will find that information sheets serve as an excellent guide for presenting the background knowledge necessary to develop the skills specified in the unit objective.

Students should read the information sheets before the information is discussed in class. Students may take additional notes on the information sheets.

Transparency Masters

Transparency masters provide information in a special way. The students may see as well as hear the material being presented, thus reinforcing the learning process. Transparencies may present new information or they may reinforce information presented in the information sheets. They are particularly effective when identification is necessary.

Transparencies should be made and placed in the notebook where they will be immediately available for use. Transparencies direct the class's attention to the topic of discussion. They should be left on the screen only when topics shown are under discussion.

Job Sheets

Job sheets are an important segment of each unit. The instructor should be able to and in most situations should demonstrate the skills outlined in the job sheets. Procedures outlined in the job sheets give direction to the skill being taught and allow both student and teacher to check student progress toward the accomplishment of the skill. Job sheets provide a ready outline for students to follow if they have missed a demonstration. Job sheets also furnish potential employers with a picture of the skills being taught and the performances which might reasonably be expected from a person who has had this training.

Assignment Sheets

Assignment sheets give direction to study and furnish practice for paper and pencil activities to develop the knowledges which are necessary prerequisites to skill development. These may be given to the student for completion in class or used for homework assignments. Answer sheets are provided which may be used by the student and/or teacher for checking student progress.

Test and Evaluation

Paper-pencil and performance tests have been constructed to measure student achievement of each objective listed in the unit of instruction. Individual test items may be pulled out and used as a short test to determine student achievement of a particular objective. This kind of testing may be used as a daily quiz and will help the teacher spot difficulties being encountered by students in their efforts to accomplish the unit objective. Test items for objectives added by the teacher should be constructed and added to the test.

Test Answers

Test answers are provided for each unit. These may be used by the teacher and/or student for checking student achievement of the objectives.

OUTBOARD REPAIR

INSTRUCTIONAL/OCCUPATIONAL ANALYSIS

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
UNIT I: ELECTRICAL REMOTE CONTROL ASSEMBLY	
	1. Parts identification
	2. Component operation
	3. Choke solenoid parts
	4. Types of shift controls
5. Disassemble and reassemble electrical remote control assembly	
6. Inspect and adjust safety switch and warm-up lever	
7. Service electrical component parts of remote control assembly	
UNIT II: MECHANICAL REMOTE CONTROL ASSEMBLY	
	1. Identify parts
2. Disassemble and reassemble a mechanical remote control assembly	
3. Replace a nylon barrel and an inner core wire	
4. Adjust shift and throttle control cables	
UNIT III: TILT ASSEMBLIES	
	1. Terms and definitions
	2. Types of assemblies
	3. Parts of a hydraulic tilt
	4. Parts of a manual tilt

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
5. Service hydraulic tilt assembly	
6. Disassemble and reassemble the manual tilt assemble	
UNIT IV: EXHAUST HOUSING	
	1. Terms and definitions
	2. Identify parts
	3. Functions of wet sleeves, exhaust relief and exhaust housings
4. Remove, inspect, and replace an exhaust housing	
UNIT V: PROPELLER AND TRIM TABS	
	1. Terms and definitions
	2. Parts
	3. Types of propellers
	4. Materials for constructing propellers
	5. Trim tab purposes
6. Remove, inspect and install a propeller	
7. Remove, Inspect, install and adjust a trim tab	
UNIT VI: COOLING SYSTEM	
	1. Terms and definitions
	2. Parts of cooling system
	3. Parts of water pump
	4. Pump impeller positions
	5. Thermostat operation
	6. Cooling system operation

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
7. Remove, inspect and install a water pump	
8. Remove, inspect, and install a thermostat	
UNIT VII: MECHANICAL GEARCASE	
	1. Terms and definitions
	2. Parts of gearcase
	3. Purposes of parts
4. Disassemble, reassemble and service a one piece gearcase	
5. Disassemble, inspect, reassemble and service a two-piece mechanical gearcase	
UNIT VIII: ELECTRICAL GEARCASE	
	1. Terms and definitions
	2. Functions of shift solenoids
	3. Parts of a gearcase
4. Disassemble an electrical gearcase	
5. Reassemble an electrical gearcase	
UNIT IX: FUEL SUPPLY SYSTEMS	
	1. Terms and definitions
	2. Parts of a pressurized fuel system
	3. Parts of a vacuum fuel system
	4. Fuel system problems
	5. Engine problems

JOB TRAINING: What the Worker Should Be Able to Do (Psychomotor)	RELATED INFORMATION: What the Worker Should Know (Cognitive)
6. Disassemble, service and reassemble a pressurized fuel system	
7. Disassemble, service and reassemble a vacuum fuel system	

TOOLS

(NOTE: These are the recommended tools and equipment necessary to complete the jobs required in these instructional materials.)

Hand Tool Assortment:
- Ball-peen hammer - one pound
- Slip joint pliers
- Screwdrivers
  - 4" standard
  - 1 1/2" standard
  - 8" standard
  - 6" standard
- Adjustable wrench
- Phillips screwdrivers
  - 6"
  - 1 1/2"
  - 8"
- 3/8" drive reversible ratchet
- 3/8" drive standard socket set
- 1/4" drive reversible ratchet
- 1/4" drive standard socket set
- 3/8" drive extension bar - 3 in.
- 3/8" drive extension bar - 7 1/2 in.
- Starter punch
- Cold chisel
- Combination wrench set 7/16 to 7/8 in.
- Universal joint
- Open end wrench set - metric
- 3/8 drive socket set - metric
- Safety glasses

Other Tools and Equipment:
- Combination wrench set - metric
- Vernier caliper
- Drain pan
- Hex key set
- Inside micrometer
- Outside micrometer
- Dial indicator
- End wrenches
- Impact screwdriver set
- Snap ring pliers
- T-handle box wrench, 16 mm
- Arbor press or bench vise
- Feeler gauge
- Flat surface plate
- Machinist's steel rule
- Calipers
- Surface block
- Case divider tool
- Impact driver
- 3/8" drive phillips screwdriver socket
- Soft face hammer
- Tape measure
- Cleaning pan
- Cleaning brush
- Grease pan
- Hot plate
- Thermomelt stick
- Plastic hammer
- Parts washing pan
- Pin wrench
- Propane torch
- Seal driver set
- Meter/kilogram torque wrench
- Soft drift
- Nipple wrench
- Bushing driver set
- Brass drift
- Pry bar
- Pliers
- Measuring container
- Cylinder gauge
- Hydraulic press
- Drift punch
- V-blocks
- Surface plate
- DC voltmeter
- DC ammeter
- Test lamp
- Ohmmeter
- Tachometer
- Flywheel pullers
- Float level gauge
- 0-1" telescoping gauge
- Clutch head screwdriver set
- Battery clamp puller
- Battery hydrometer
- Battery post cleaner
- Funnel
- Thread repair kit
- Drill motor
- Chisel set
- Twist Drill set
- Special tools as required

REFERENCES

Evinrude Service Manual. Milwaukee: Evinrude Motors/Outboard Marine Corp., 1971.

Johnson Outboard Motor Service Manual. Waukegan, Illinois: Johnson Motors/Outboard Marine Corp., 1973.

Mercury Marine Service Manual. Models 1966 - 1976. Fond du Lac, Wisconsin: Mercury Marine Outboard/Brunswick Corp., 1976.

Miller, Conrad. *Small Boat Engine.* New York: Sheridan House, 1970.

Outboard Motor Service Manual. Vol. 2. 6th ed. Kansas City, Missouri: Abos Marine Publications Division/Intertec Publishing Corp., 1973.

The R.P.M. System. Milwaukee, Wisconsin: Evinrude Motors/Outboard Marine Corp., 1972.

ELECTRICAL REMOTE CONTROL ASSEMBLY
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify the parts of an electrical remote control assembly, match the parts to the operations, and identify the parts of an electrical choke solenoid assembly. The student should also be able to name two types of shift controls and demonstrate the ability to disassemble and reassemble an electrical remote control assembly, service the electrical parts, and inspect and adjust the safety switch and the warm-up lever. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Identify the parts of an electrical remote control assembly.
2. Match the parts of the electrical remote control assembly to the correct operations.
3. Identify the parts of the electrical choke solenoid assembly.
4. Name two types of shift controls.
5. Demonstrate the ability to:
   a. Disassemble and reassemble electrical remote control assembly.
   b. Inspect and adjust safety switch and warm-up lever.
   c. Service electrical component parts of remote control assembly.

ELECTRICAL REMOTE CONTROL ASSEMBLY
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide student with objective sheet.

B. Provide student with information and job sheets.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Demonstrate and discuss the procedures outlined in the job sheets.

G. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Complete job sheets.

D. Complete activities assigned by instructor.

E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1--Parts of Electrical Remote Control Assembly

2. TM 2--Parts of Electrical Choke Solenoid Assembly

D. Job sheets

1. Job Sheet #1--Disassemble and Reassemble Electrical Remote Control Assembly

2. Job Sheet #2--Inspect and Adjust Safety Switch and Warm-up Lever

3. Job Sheet #3--Service Electrical Component Parts of Remote Control Assembly

E. Test

F. Answers to test

II. References:

A. *Johnson Outboard Motor Service Manual.* Waukegan, Illinois: Johnson Motors/Outboard Marine Corp., 1973.

B. Miller, Conrad. *Small Boat Engine.* New York: Sheridan House, 1970.

C. *Outboard Motor Service Manual.* Vol. 2. 6th ed. Kansas City, Missouri: Abos Marine Publications Division/Intertec Publishing Corp., 1973.

ELECTRICAL REMOTE CONTROL ASSEMBLY
UNIT I

INFORMATION SHEET

I. Parts of electrical remote control assembly (Transparency 1)

A. Warm-up lever stop screw

B. Shift control clevis

C. Control lever friction adjustment

D. Choke switch

E. Starting ignition switch

F. Throttle control clevis

G. Throttle cam

H. Warm-up lever

I. Casing guide

J. Trunnions

K. Cover housing

L. Throttle control lever

M. Motor temperature warning horn

N. Neutral safety switch

II. Operations of electrical remote control assembly parts

A. Warm-up lever stop screw--Limits throttle advance during warm-up

B. Shift control clevis--Connecting device for control cables

C. Choke switch--Operates the choke solenoid on engine

D. Throttle cam--Changes the orbital movement of the throttle control lever to a vertical movement of the control cable

E. Warm-up lever--Opens the throttle sufficiently to start the engine and to control the fast idle speed for warm-up

INFORMATION SHEET

F. Casing guide--Provides stiffness to keep the cables from bending as they move in and out during the controlling process

G. Trunnions--Adjust the length of the casing guides

H. Throttle control lever--Applies force to the throttle cam

I. Motor temperature warning horn--Warning device if the engine is overheating

J. Neutral safety switch--Completes the starting circuit only when the throttle control lever is in neutral position

K. Solenoid assembly--Iron core surrounded by a coil of wire which moves due to magnetic attraction when an electrical current is fed to the coil

III. Parts of electrical choke solenoid assembly (Transparency 2)

A. Solenoid plunger

B. Solenoid assembly

C. Solenoid plunger spring

D. Ground wire

E. Solenoid choke spring

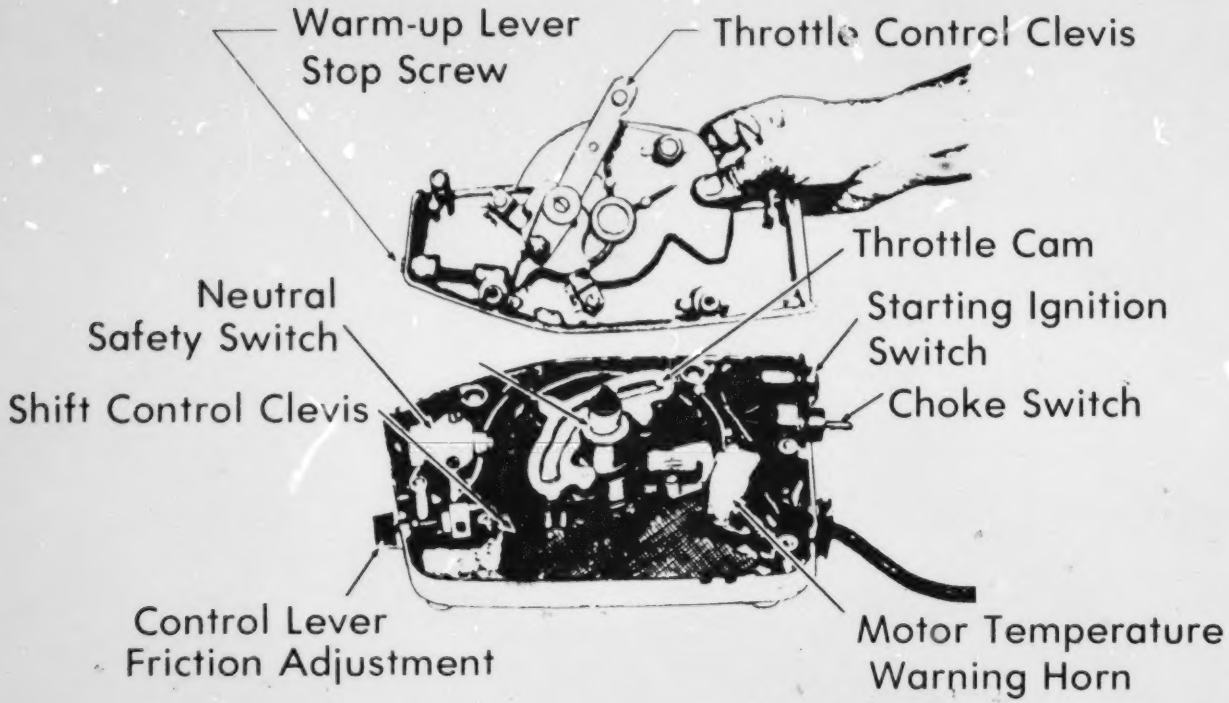
F. Primary wire to choke switch

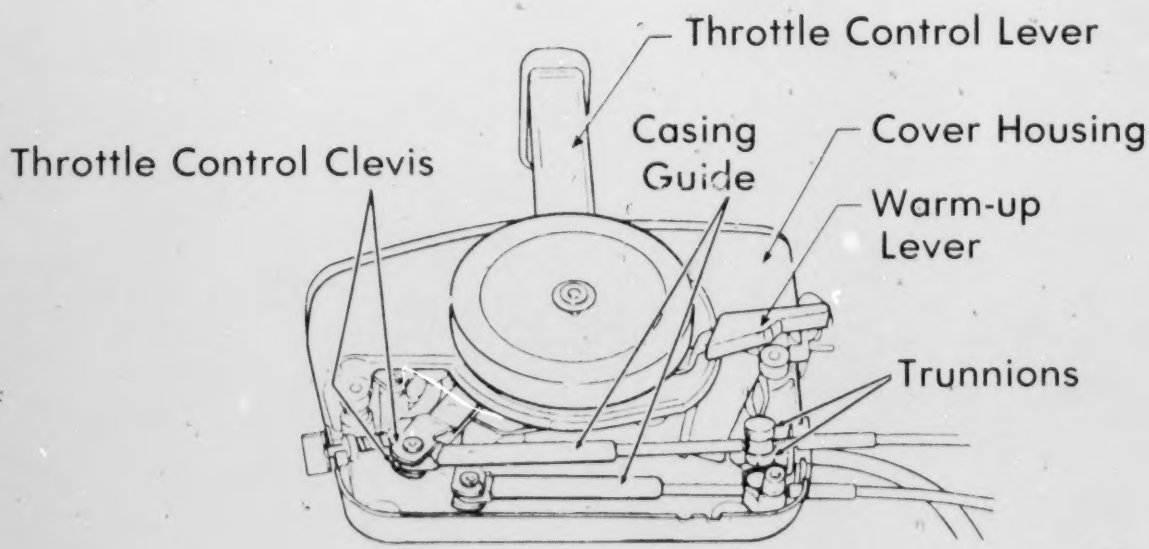
IV. Types of shift controls

A. Manual

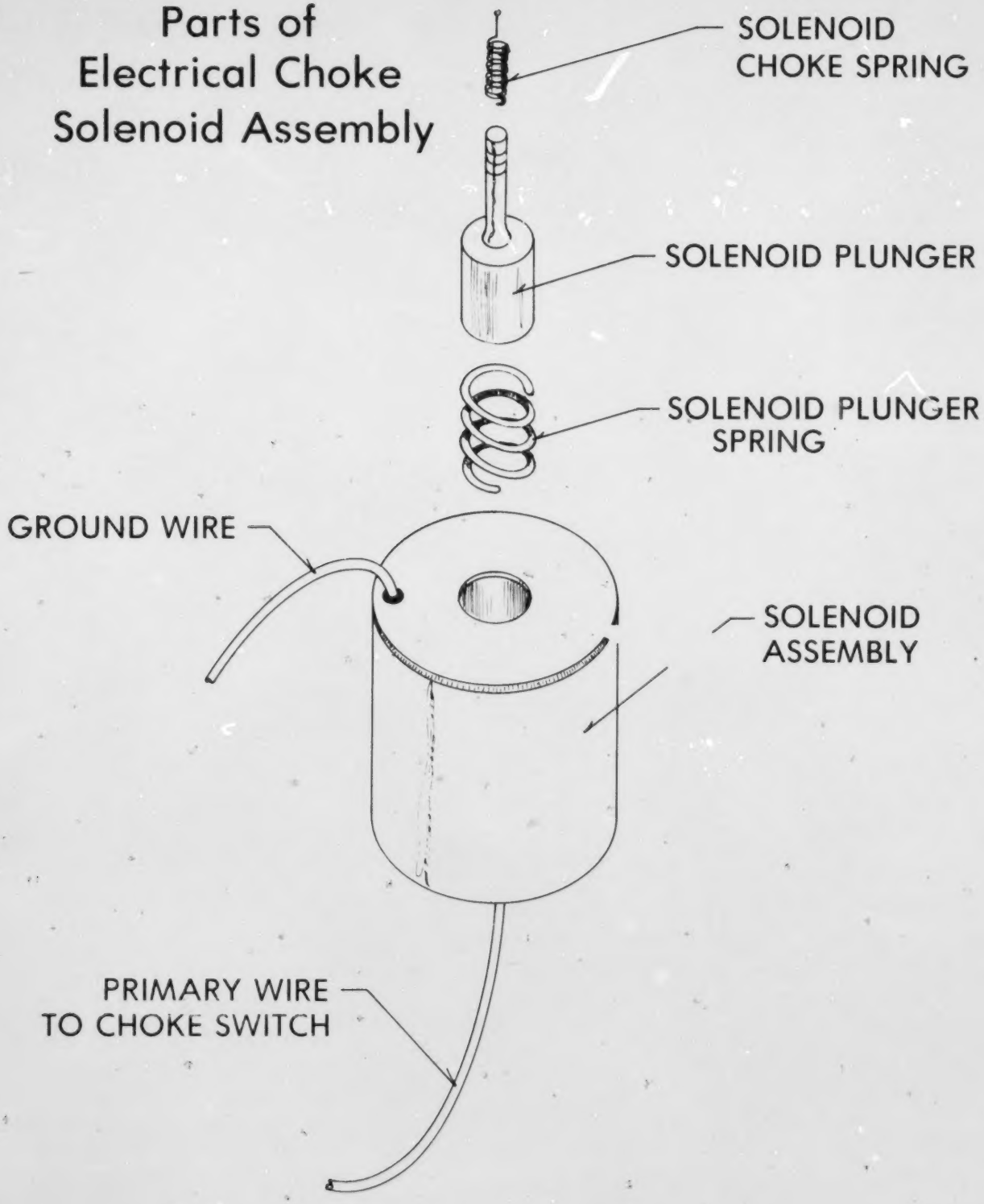
B. Electrical

Parts of Electrical Remote Control Assembly





Parts of Electrical Choke Solenoid Assembly



ELECTRICAL REMOTE CONTROL ASSEMBLY
UNIT I

JOB SHEET #1 DISASSEMBLE AND REASSEMBLE ELECTRICAL REMOTE CONTROL ASSEMBLY

I. Tools and materials

A. Hand tool assortment

B. Parts tray

C. Electrical remote control assembly

D. Shop towels

E. Appropriate service manual

II. Procedure

A. Disconnect battery cables before attempting to work on remote control assembly

B. Remove control box from boat, if needed

C. Remove control access cover screws and cover (Figure 1)

(NOTE: On some models the control lever must be placed in the neutral position.)

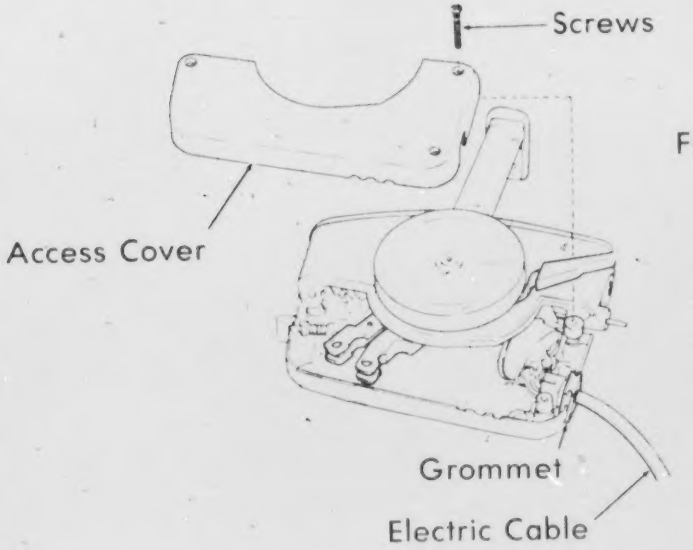
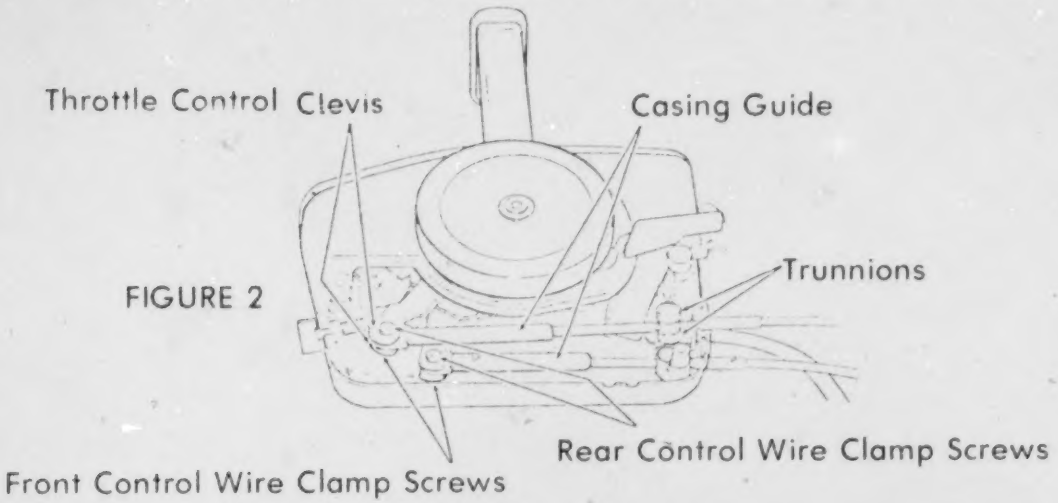


FIGURE 1

D. Lift both control cable casing guides and trunnions from control assembly (Figure 2)

(NOTE: Some casing guides have wire clamp screws that act as clevis pins.)

FIGURE 2

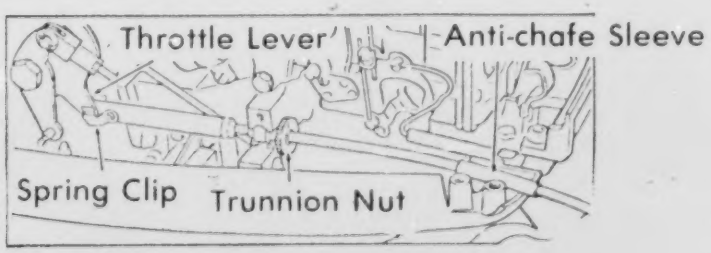


E. Lift electric cable and grommet out of slot

F. Remove throttle control cable at engine (Figure 3)

(NOTE: Some throttle cables are secured with a locknut and washer.)

FIGURE 3



JOB SHEET #1

G. Remove shift control cable from shift lever at engine (Figure 4)

(NOTE: Some shift control cables are secured with a spring clip.)

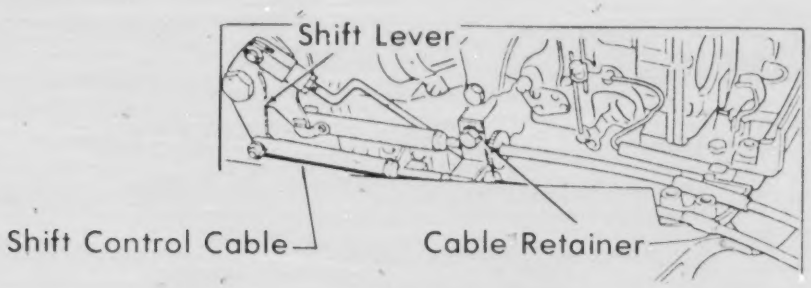


FIGURE 4

H. Clean for reassembly

I. Inspect parts for wear or damage

J. Replace all engine components

K. Reassemble remote control assembly

ELECTRICAL REMOTE CONTROL ASSEMBLY
UNIT I

JOB SHEET #2 INSPECT AND ADJUST SAFETY SWITCH AND WARM-UP LEVER

I. Tools and materials

A. Hand tool assortment

B. Appropriate service manual

II. Procedure

A. Adjust safety switch

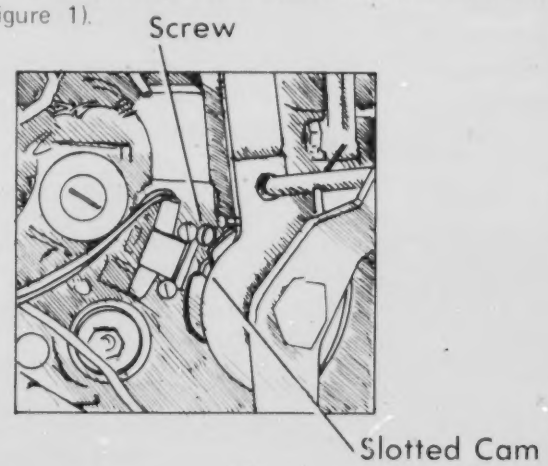
1. Loosen adjustment screws

2. With ignition off put gearshift in neutral

3. Advance throttle control lever to full open position

4. Hold starter key on, and slowly retard throttle control lever until engine starts (Figure 1).

FIGURE 1



5. Adjust slotted cam on throttle control lever

(NOTE: Engine should turn over between 2500 and 3000 RPM, or within service manual specifications.)

6. Tighten screws after adjustment

B. Adjust warm-up lever

JOB SHEET #2

1. Place throttle control lever in neutral position and warm-up lever in full-start position (Figure 2)

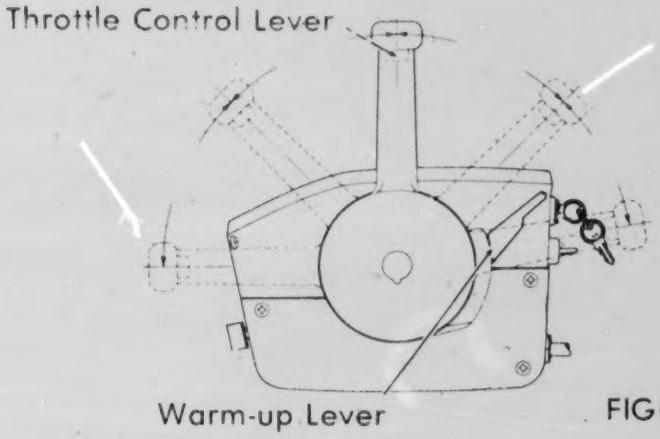


FIGURE 2

2. Back off warm-up lever stop screw until engine will not crank with key switch

3. Holding key switch in the start position, adjust stop screw until the engine starts cranking with the warm-up lever in the full-start position (Figure 3)

FIGURE 3

ELECTRICAL REMOTE CONTROL ASSEMBLY
UNIT I

JOB SHEET #3 SERVICE ELECTRICAL COMPONENT PARTS
OF REMOTE CONTROL ASSEMBLY

I. Tools and materials

A. Hand tool assortment

B. Parts tray

C. Continuity test light or ohmmeter

D. Appropriate service manual

E. Thermometer

F. Pan of oil

II. Procedure

(NOTE: Compare your checks with service manual specifications and replace parts as needed.)

A. Remove remote control outer cover

B. Check neutral safety switch using a continuity test light (Figure 1)

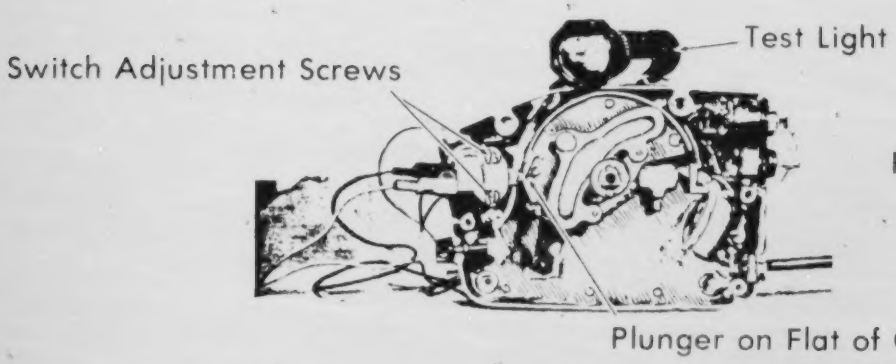


FIGURE 1

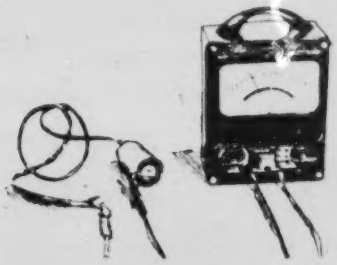
C. Check choke switch using a test light

D. Check choke wire from remote control to choke solenoid using a test light

JOB SHEET #3

E. Check choke solenoid using a test light or an ohmmeter (Figure 2)

FIGURE 2



Lo-ohms Scale

F. Check motor temperature warning horn

1. Turn key switch to on position
2. Touch horn connector to ground

(NOTE: Horn should blow. If it does not, check for shorts, open circuit, or faulty horn.)

G. Check temperature heat switch

1. Remove heat switch from engine block (Figure 3)

FIGURE 3

2. Submerge the heat switch in a pan of oil with the thermometer

JOB SHEET #3

3. Connect test light or ohmmeter to heat switch (Figure 4)

FIGURE 4

4. Heat the oil and check the switch

H. Replace remote control cover

ELECTRICAL REMOTE CONTROL ASSEMBLY
UNIT I

NAME_____

TEST

1. Identify the parts of an electrical remote control assembly.

a.

b.

c.

d.

e.

f.

g.

h.

i.

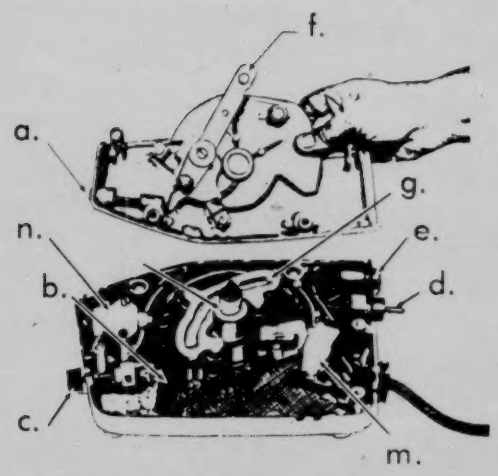
j.

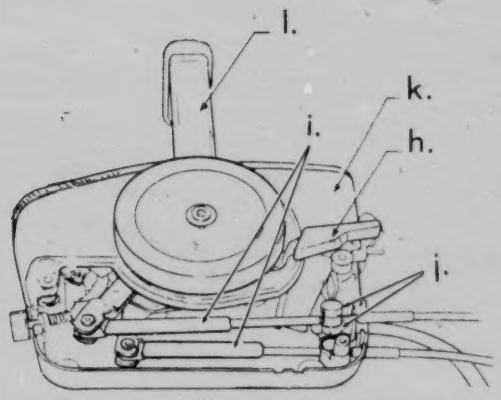
k.

l.

m.

n.





2. Match the parts of the electrical remote control assembly on the right to the correct operations.

_____a. Changes the orbital movement of the throttle control lever to a vertical movement of the control cable

_____b. Limits throttle advance during warm-up

_____c. Applies force to the throttle cam

_____d. Warning device if the engine is overheating

_____e. Operates the choke solenoid on engine

_____f. Provides stiffness to keep the cables from bending as they move in and out during the controlling process

_____g. Opens the throttle sufficiently to start the engine and to control the fast idle speed for warm-up

_____h. Adjust the length of the casing guides

_____i. Connecting device for control cables

_____j. Completes the starting circuit only when the throttle control lever is in neutral position

_____k. Iron core surrounded by a coil of wire which moves due to magnetic attraction when an electrical current is fed to the coil

1. Warm-up lever stop screw
2. Shift control clevis
3. Choke switch
4. Throttle cam
5. Warm-up lever
6. Casing guide
7. Trunnions
8. Throttle control lever
9. Motor temperature warning horn
10. Neutral safety switch
11. Solenoid assembly

3. Identify the parts of the electrical choke solenoid assembly.

a.

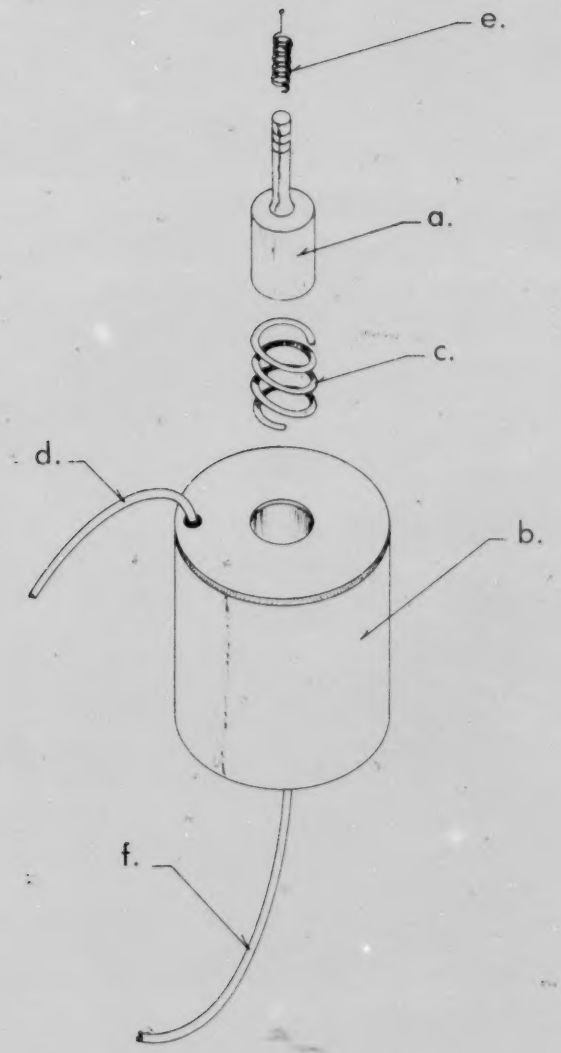
b.

c.

d.

e.

f.



4. Name two types of shift controls.

   a.

   b.

5. Demonstrate the ability to:

   a. Disassemble and reassemble electrical remote control assembly.

   b. Inspect and adjust safety switch and warm-up lever.

   c. Service electrical component parts of remote control assembly.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

ELECTRICAL REMOTE CONTROL ASSEMBLY
UNIT I

ANSWERS TO TEST

1. a. Warm-up lever stop screw
   b. Shift control clevis
   c. Control lever friction adjustment
   d. Choke switch
   e. Starting ignition switch
   f. Throttle control clevis
   g. Throttle cam
   h. Warm-up lever
   i. Casing guide
   j. Trunnions
   k. Cover housing
   l. Throttle control lever
   m. Motor temperature warning horn
   n. Neutral safety switch

2. a. 4 e. 3 i. 2
   b. 1 f. 6 j. 10
   c. 8 g. 5 k. 11
   d. 9 h. 7

3. a. Solenoid plunger
   b. Solenoid assembly
   c. Solenoid plunger spring
   d. Ground wire
   e. Solenoid choke spring
   f. Primary wire to choke switch

4. a. Manual

   b. Electrical

5. Performance skills evaluated to the satisfaction of the instructor

MECHANICAL REMOTE CONTROL ASSEMBLY
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify the main parts of the mechanical remote control assembly. The student should also be able to dissassemble and reassemble a remote control assembly, replace a nylon barrel and an inner core wire, and adjust the shift and throttle control cables. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Identify the main parts of the mechanical remote control assembly.
2. Demonstrate the ability to:
   a. Disassemble and reassemble a mechanical remote control assembly.
   b. Replace a nylon barrel and an inner core wire.
   c. Adjust shift and throttle control cables.

MECHANICAL REMOTE CONTROL ASSEMBLY
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide student with objective sheet.

B. Provide student with information and job sheets.

C. Make transparency.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Demonstrate and discuss the procedures outlined in the job sheets.

G. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Complete job sheets.

D. Complete activities assigned by instructor.

E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency master: TM 1--Parts of Mechanical Remote Control Assembly

D. Job sheets

1. Job Sheet #1--Disassemble and Reassemble a Mechanical Remote Control Assembly

2. Job Sheet #2--Replace a Nylon Barrel and an Inner Core Wire

3. Job Sheet #3--Adjust Shift and Throttle Control Cables

E. Test

F. Answers to test

II. References:

A. *Mercury Marine Service Manual.* Models 1966 - 1976. Fond du Lac, Wisconsin: Mercury Marine Outboard/Brunswick Corp., 1976.

B. *Johnson Outboard Motor Service Manual.* Waukegan, Illinois: Johnson Motors/Outboard Marine Corp., 1973.

MECHANICAL REMOTE CONTROL ASSEMBLY
UNIT II

INFORMATION SHEET

I. Parts of mechanical remote control assembly (Transparency 1)

A. Warm-up lever

B. Remote control housing

C. Throttle lever

D. Face cam

E. Cam follower

F. Shift lever

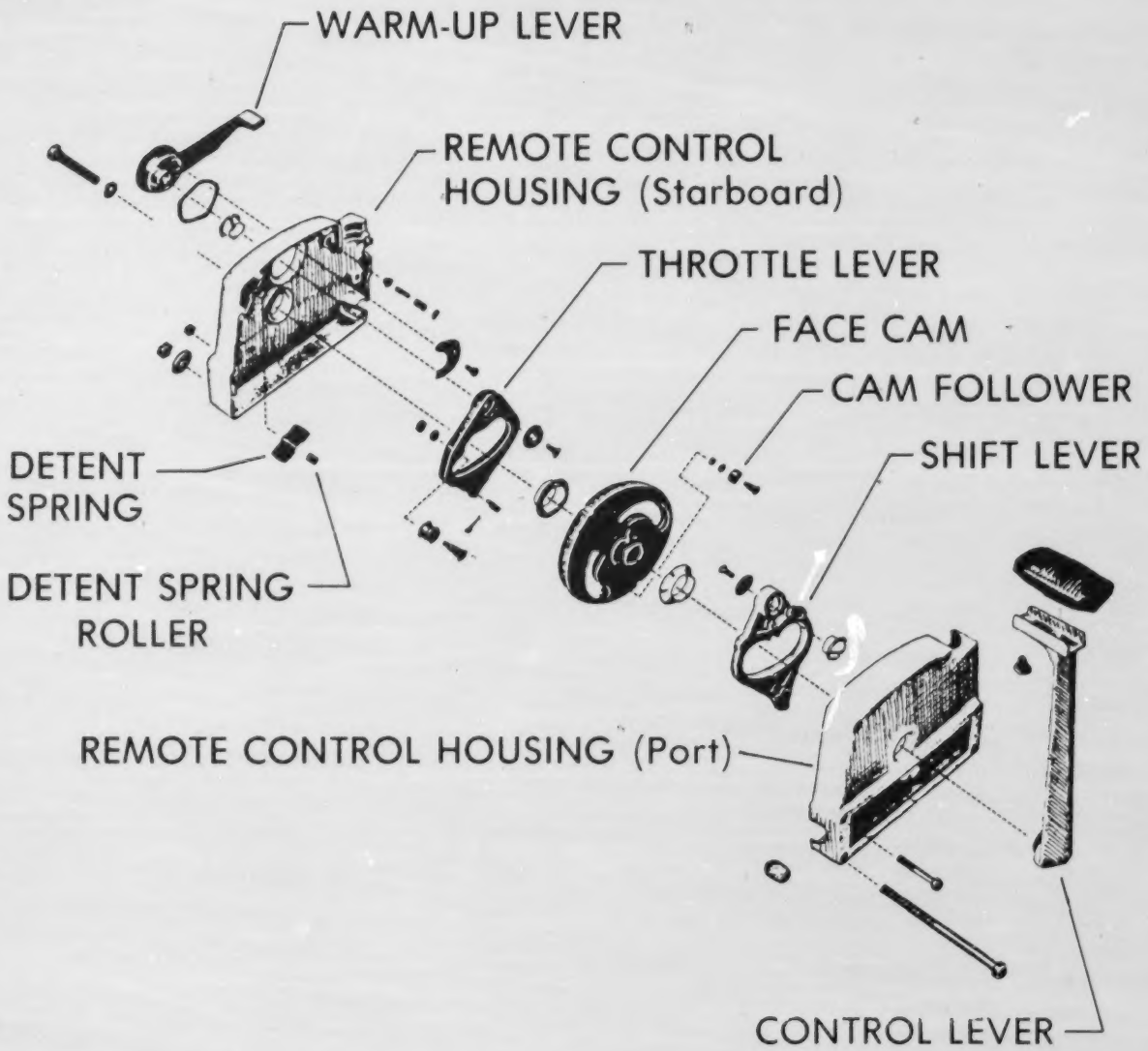
G. Control lever

H. Remote control housing

I. Detent spring roller

J. Detent spring

PARTS OF MECHANICAL REMOTE CONTROL ASSEMBLY



MECHANICAL REMOTE CONTROL ASSEMBLY
UNIT II

JOB SHEET #1 DISASSEMBLE AND REASSEMBLE A MECHANICAL REMOTE CONTROL ASSEMBLY

I. Tools and materials

A. Hand tool assortment

B. Anticorrosion grease

C. Parts tray

D. Appropriate service manual

II. Procedure

A. Disassemble remote control assembly

1. Remove screws which hold housing halves together

2. Separate halves (Figure 1)

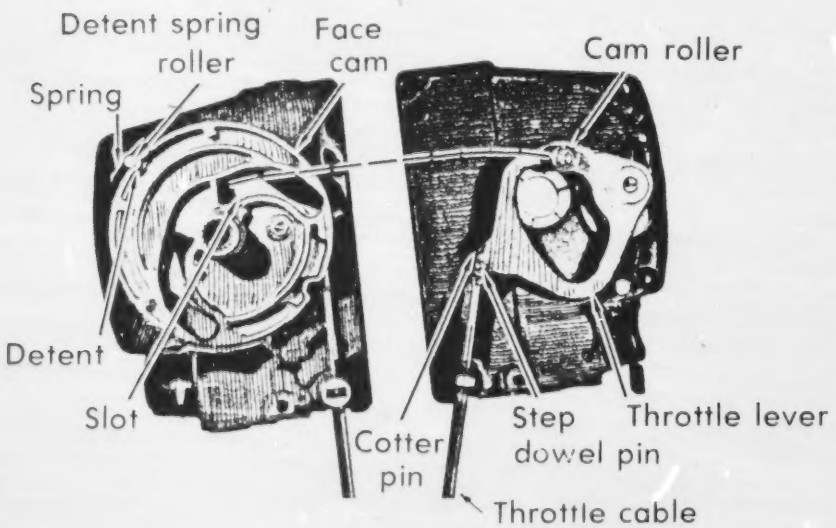


FIGURE 1

3. Remove detent springs and detent spring roller (Figure 1)

4. Lift face cam out (Figure 2)

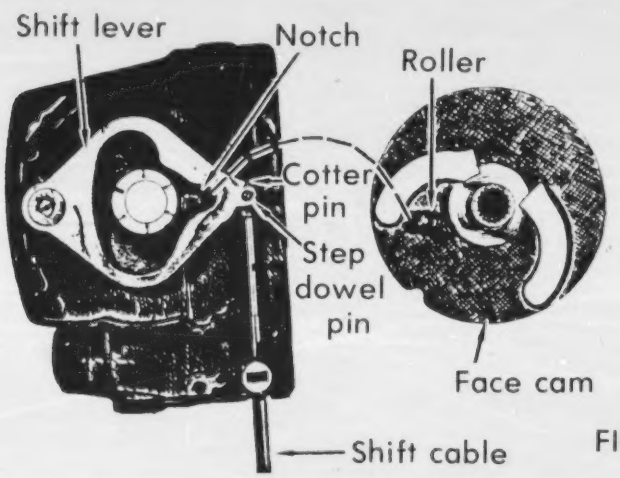


FIGURE 2

5. Remove cotter pin and step dowel pin from shift lever (Figure 2)

6. Remove shift cable (Figure 2)

7. Remove cotter pin and step dowel pin from throttle lever (Figure 1)

8. Remove throttle cable (Figure 1)

9. Clean and inspect all parts

B. Reassemble remote control assembly

1. Place anticorrosion grease in cable socket and install shift cable

2. Coat step dowel pin with a thin film of anticorrosion grease and install step dowel pin thru shift lever and lever cable end

3. Place face cam in position over shift lever (Figure 2)

(NOTE: Roller on face cam must fit into notch on shift lever.)

JOB SHEET #1

4. Install detent spring and detent spring roller (Figure 3)

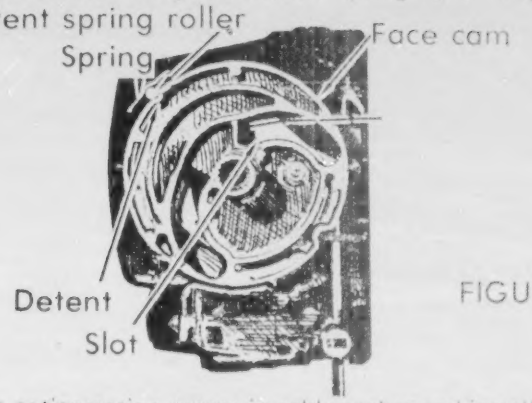


FIGURE 3

5. Place anticorrosion grease in cable socket and install throttle cable

6. Coat step dowel pin with a thin film of anticorrosion grease and install step dowel pin thru throttle lever cable end

7. Place halves together (Figure 4)

(NOTE: If housing halves do not fit together, cam roller is not entering face cam slot.)

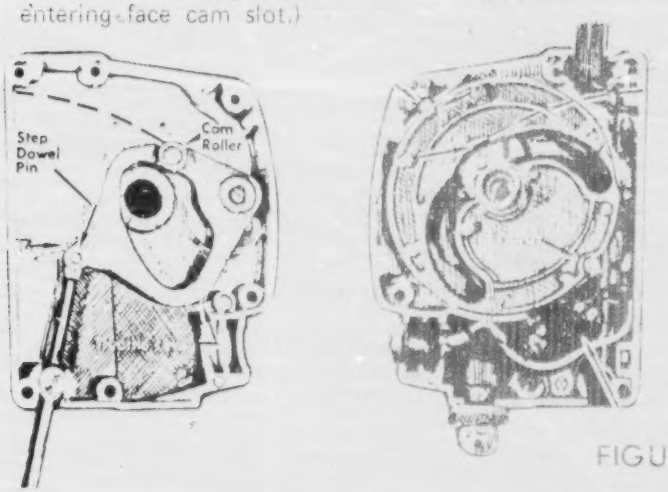


FIGURE 4

8. Place screws thru housing halves and tighten evenly

9. Set handle into splined hub and turn until neutral position is noted

10. Reset handle so it is in a vertical position

11. Install handle screw and lock washer and tighten securely

MECHANICAL REMOTE CONTROL ASSEMBLY
UNIT II

JOB SHEET #2--REPLACE A NYLON BARREL AND AN INNER CORE WIRE

I. Tools and materials

A. Hand tool assortment

B. Anticorrosion grease

C. Locktite

D. Ruler

II. Procedure

A. Replace nylon barrel

1. Remove cables from remote control box

2. Remove control wire clamp screw from casing guide (Figure 1)

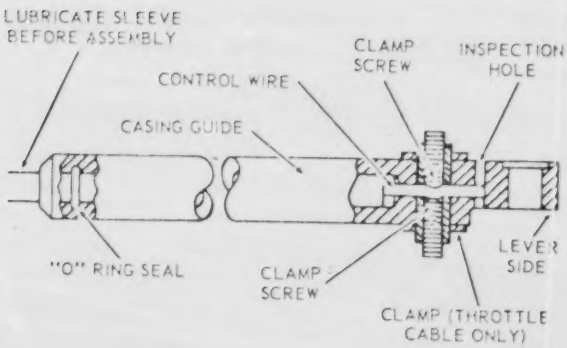


FIGURE 1

3. Remove casing guide

4. Remove control wire

5. Remove burrs on control wire and round off the end of the wire

6. Remove damaged nylon barrel

JOB SHEET #2

7. Measure the distance from end of cable to center of nylon barrel (Figure 2)

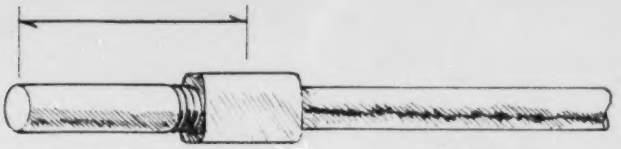


FIGURE 2

8. Install new nylon barrel on the cable the same distance as damaged barrel or as service manual specifies

(NOTE: Large diameter of hole in barrel faces cable. Brass barrel assembly must be staked or locked in place with locktite.)

B. Replace inner core wire

1. Round off end of new wire

(NOTE: This will prevent damage to inner liner of cable when wire is inserted.)

2. Lubricate the core wire and slide it into the outer cable

3. Insert core wire until able to grip opposite end

4. Pull core wire out of outer cable and measure to service manual specifications (Figure 3)

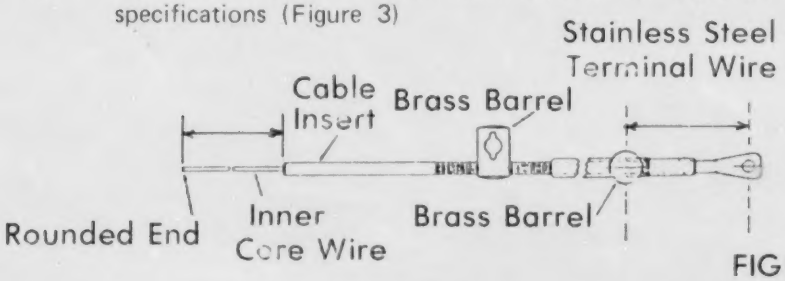


FIGURE 3

5. Install into remote control box

MECHANICAL REMOTE CONTROL ASSEMBLY
UNIT II

JOB SHEET #3-ADJUST SHIFT AND THROTTLE CONTROL CABLES

I. Tools and materials

A. Hand tool assortment

B. Anticorrosion grease

C. Ruler

II. Procedure

A. Adjust shift control cable

1. Place remote control lever handle in forward position and warm-up lever completely down

2. Install cable into grommet on engine cowling with barrel inside cowling

3. Shift transmission into forward gear

4. Adjust barrel connector on cable so that hole in barrel aligns with hole in clevis, and hole in cable end aligns with peg on shift cable end anchor (Figure 1)

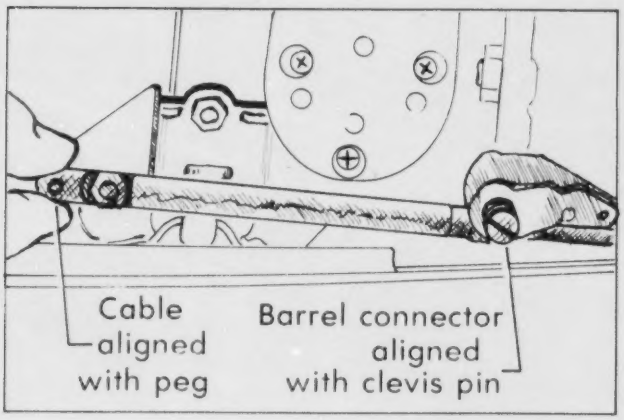


FIGURE 1

JOB SHEET #3

5. Insert clevis pin thru barrel and opposite side of clevis and turn 90° to lock the pin in place (Figure 2)

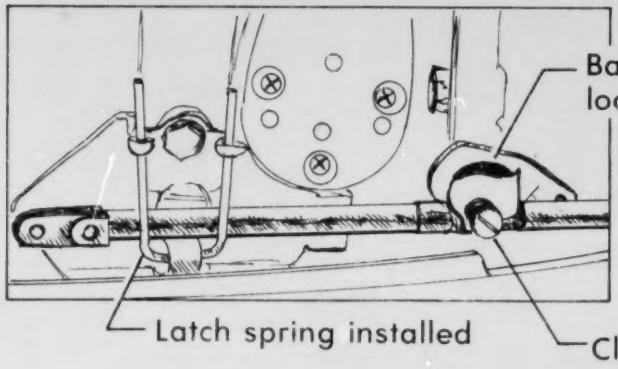


FIGURE 2

6. Fasten cable end in place by latching hairpin spring clamp (Figure 2)

7. Place remote control lever handle in neutral, and check that engine is in neutral gear

(NOTE: If not in neutral gear, repeat steps 3, 4, and 5.)

B. Adjust throttle control cable

1. Place remote control lever in neutral position and warm-up lever completely down

2. Install cable into grommet on engine cowling with barrel inside cowling

3. Adjust barrel on throttle cable to service manual specifications (Figure 3)

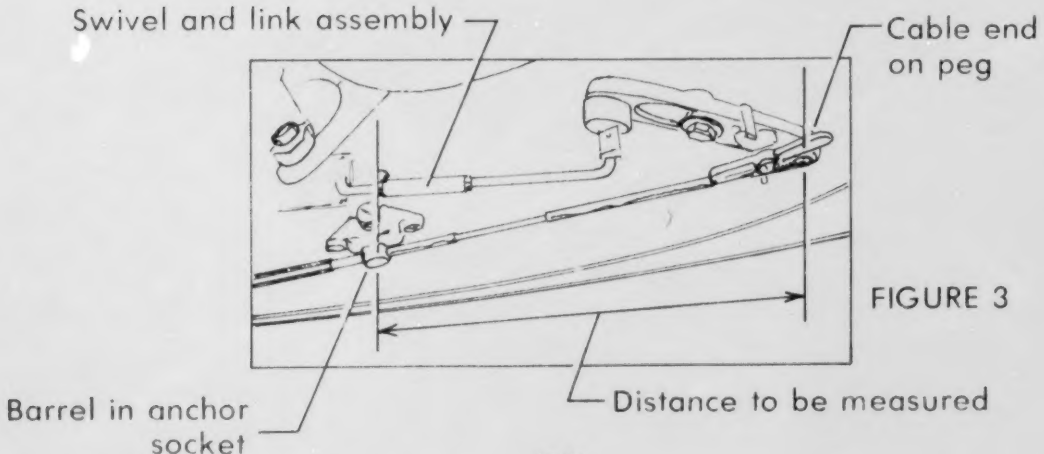


FIGURE 3

JOB SHEET #3

4. Snap cable end latch over cable end, and lock barrel in socket (Figure 4)

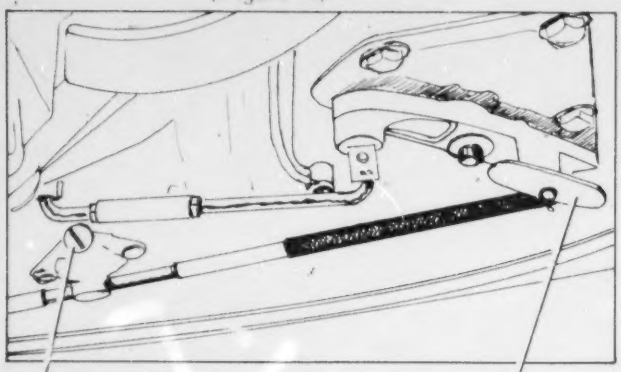


FIGURE 4

5. Move lever remote control handle to forward position and then back to neutral position

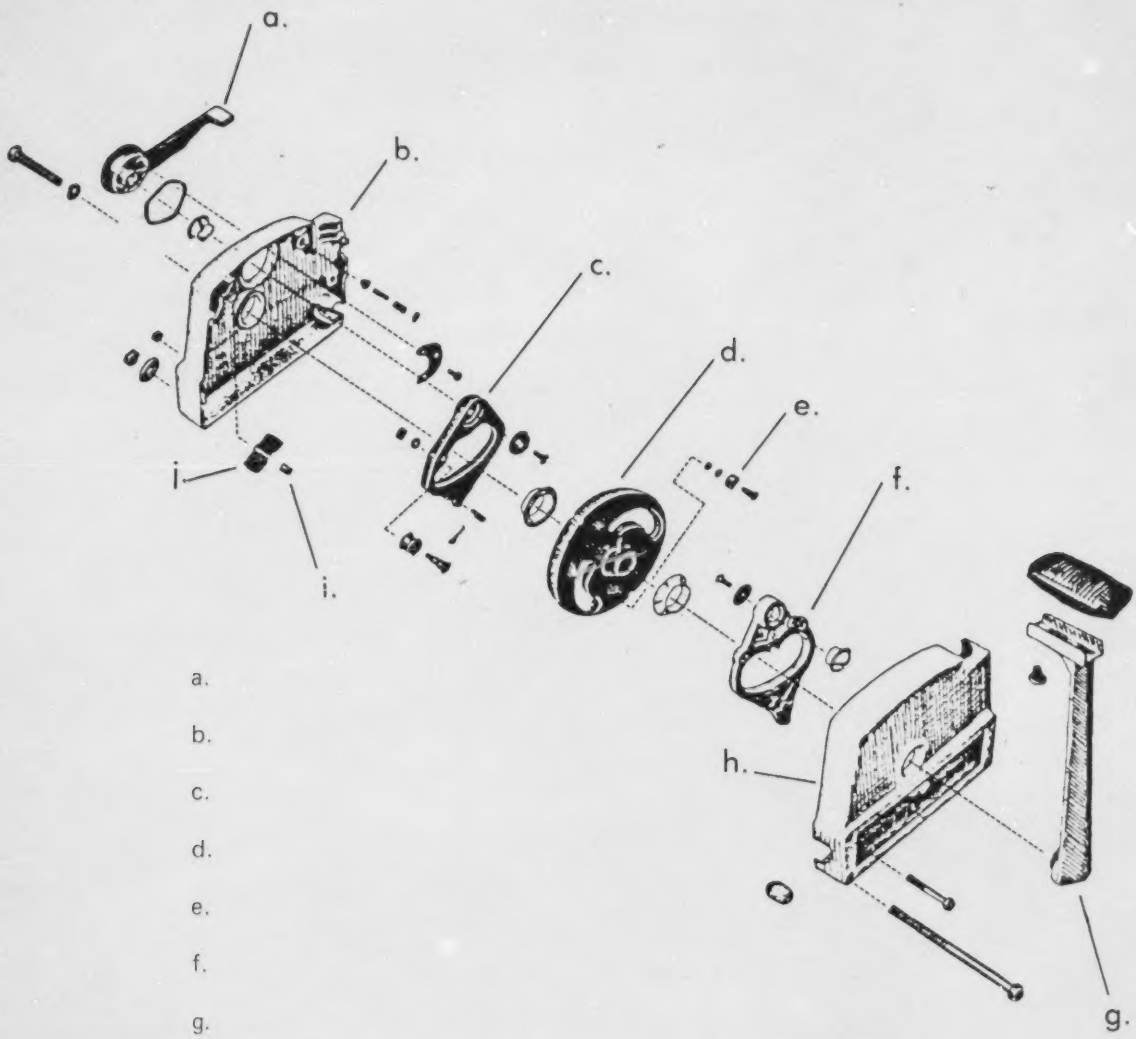
(NOTE: Check that idle stop screw rests lightly against idle stop when control handle is in neutral position. If not, repeat steps 2, 3, and 4.)

MECHANICAL REMOTE CONTROL ASSEMBLY
UNIT II

NAME_____

TEST

1. Identify the main parts of the mechanical remote control assembly.



a.

b.

c.

d.

e.

f.

g.

h.

i.

j.

2. Demonstrate the ability to:

   a. Disassemble and reassemble a mechanical remote control assembly.

   b. Replace a nylon barrel and an inner core wire.

   c. Adjust shift and throttle control cables.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

MECHANICAL REMOTE CONTROL ASSEMBLY
UNIT II

ANSWERS TO TEST

1. a. Warm-up lever
   b. Remote control housing
   c. Throttle lever
   d. Face cam
   e. Cam follower
   f. Shift lever
   g. Control lever
   h. Remote control housing
   i. Detent spring roller
   j. Detent spring
2. Performance skills evaluated to the satisfaction of the instructor

TILT ASSEMBLIES
UNIT III

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify the main parts of the hydraulic and manual tilt assemblies. The student should also be able to service a hydraulic tilt assembly and disassemble and reassemble a manual tilt assembly. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with tilt assemblies to the correct definitions.
2. Name two types of tilt assemblies.
3. Identify the parts of the hydraulic tilt assembly.
4. Identify the parts of the manual tilt assembly.
5. Demonstrate the ability to:
   a. Service the hydraulic tilt assembly.
   b. Disassemble and reassemble the manual tilt assembly.

TILT ASSEMBLIES
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide student with objective sheet.

B. Provide student with information and job sheets.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Demonstrate and discuss the procedures outlined in the job sheets.

G. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Complete job sheets.

D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1--Hydraulic Tilt Assembly

2. TM 2--Manual Tilt Assembly

D. Job sheets

1. Job Sheet #1--Service the Hydraulic Tilt Assembly

2. Job Sheet #2--Disassemble and Reassemble the Manual Tilt Assembly

E. Test

F. Answers to test

II. References:

A. *Johnson Outboard Motor Service Manual.* Waukegan, Illinois: Johnson Motors/Outboard Marine Corp., 1973.

B. *Mercury Marine Service Manual.* Models 1966 - 1976. Fond du Lac, Wisconsin: Mercury Marine Outboard/Brunswick Corp., 1976.

TILT ASSEMBLIES
UNIT III

INFORMATION SHEET

I. Terms and definitions

A. Transon--Part of the boat from which the engine is hung

B. Bleed--Remove air from a system

C. Tilt angle--Any incline of the outboard away from a vertical position

D. Limit switch--Limits the tilt angle of the outboard

E. Thrust rod--Keeps correct engine tilt angle and locks engine tilt down during reverse operation

F. Steering arm and pivot shaft--Pivot point for engine's turning radius

G. Tilt tube--Pivot point for engine's tilt angle

II. Types of tilt assemblies

A. Hydraulic

B. Manual

III. Parts of hydraulic tilt assembly (Transparency 1)

A. Hydraulic pump

B. Solenoid

C. Switch panel

D. Vent screw

E. Control knob

F. Harness connector

G. Down bleed port

H. Up bleed port

I. Fill screw

INFORMATION SHEET

IV. Parts of manual tilt assembly (Transparency 2)

A. Steering arm and pivot shaft

B. Stern brackets (port and starboard)

C. Thrust rod

D. Swivel bracket

E. Keepers

F. Nut

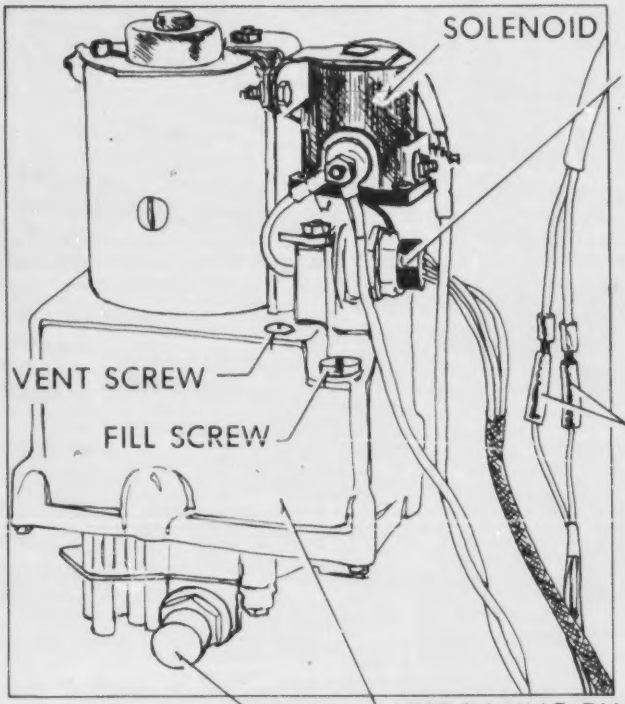
G. Shock absorber

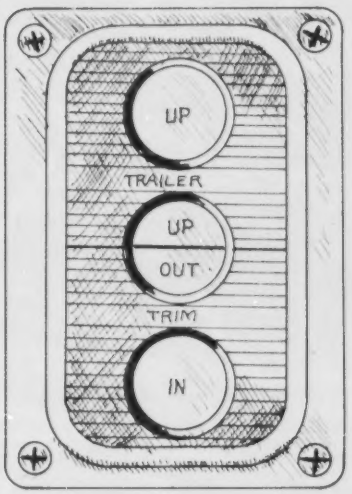
H. Reverse lock components

I. Stern bracket plate

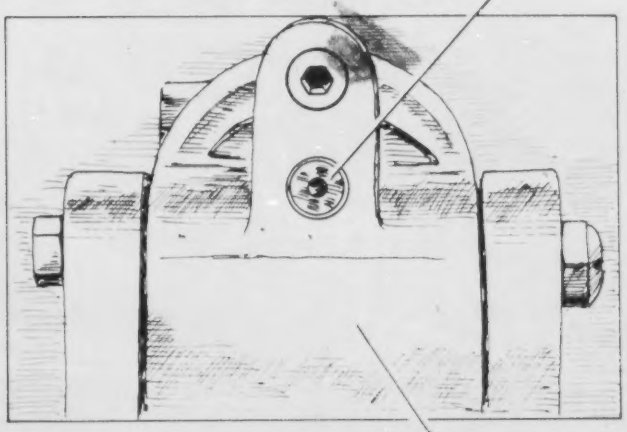
J. Tilt tube

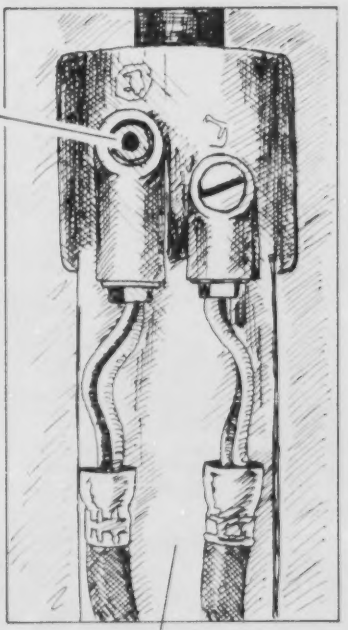
HYDRAULIC TILT ASSEMBLY





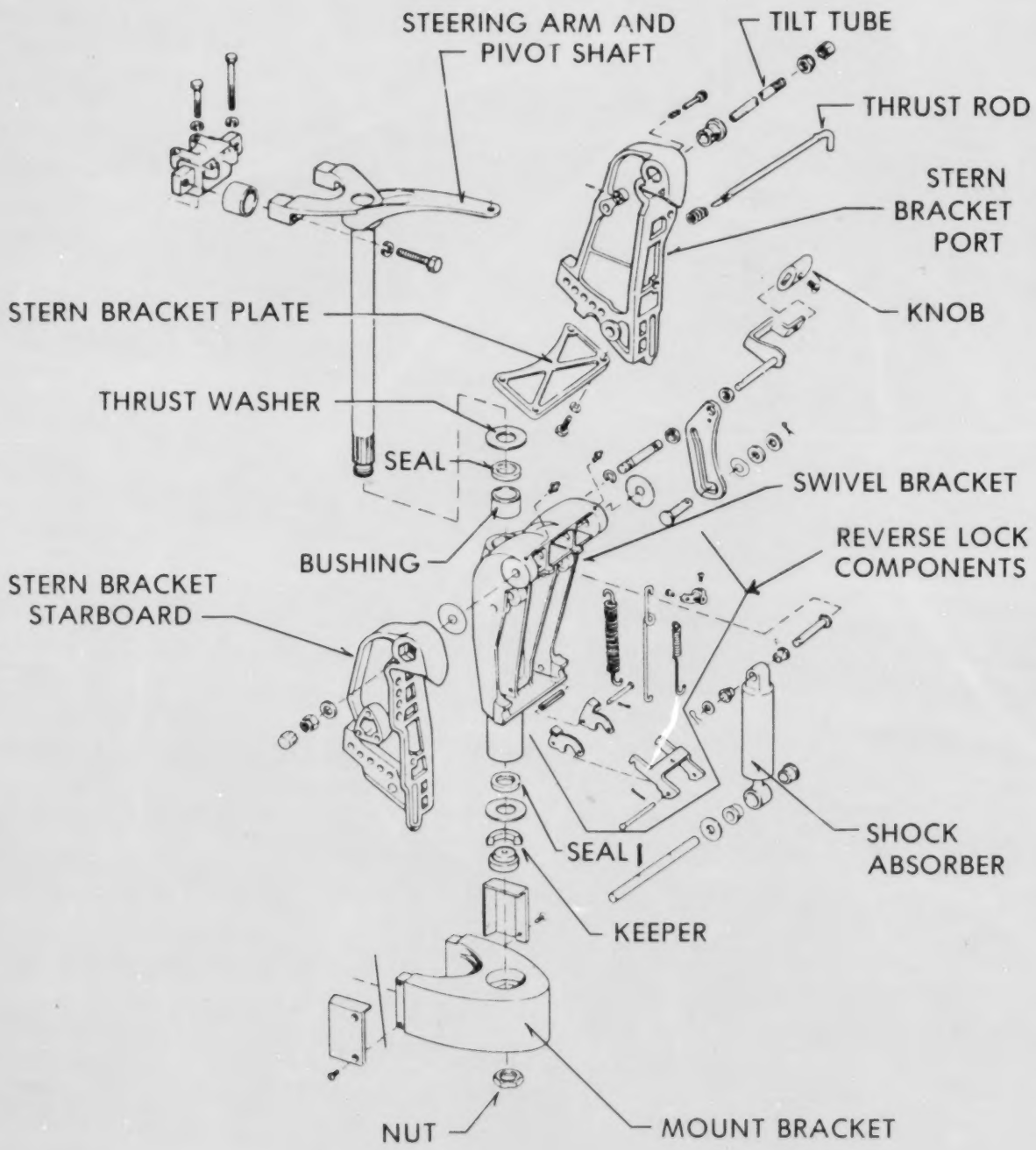
SWITCH PANEL





TM 1

MANUAL TILT ASSEMBLY



TILT ASSEMBLIES
UNIT III

JOB SHEET #1--SERVICE THE HYDRAULIC TILT ASSEMBLY

I. Tools and materials

A. Hand tool assortment

B. Hydraulic fluid

C. Oil pan

D. Appropriate service manual

II. Procedure

A. Check hydraulic system fluid level

(NOTE: This needs to be done periodically.)

1. Tilt outboard to full-up position

2. Remove "fill" plugs (Figure 1)

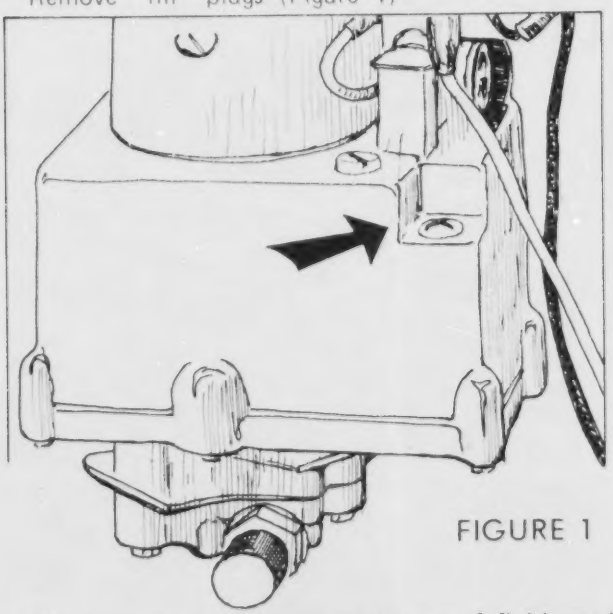


FIGURE 1

3. Fill to bottom of thread with type of fluid specified in service manual

(NOTE: If specified type is not available, use a high quality SAE 20-20w specification MS automotive oil. Do not overfill.)

4. Replace "fill" plug and return outboard to normal operating position

B. Bleed hydraulic system

1. Bleed "down" side of hydraulic system

a. Remove "down" bleed screw and O ring at top of cylinder (Figure 2)

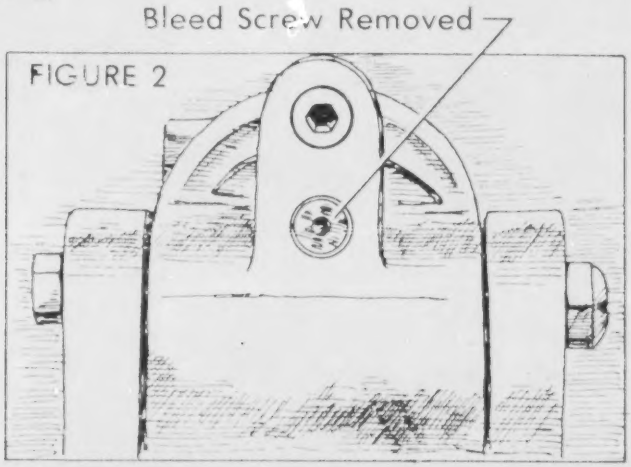


FIGURE 2

b. Press the "in" button on the switch panel for a few seconds, release, and wait for approximately one minute (Figure 3)

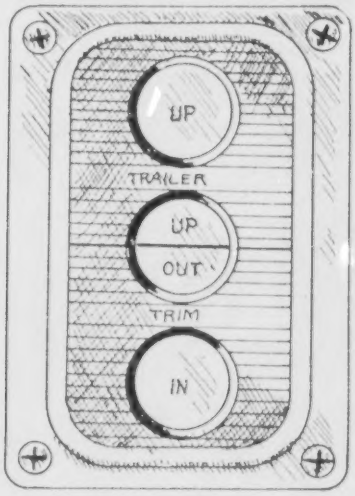


FIGURE 3

c. Repeat pumping procedure until fluid, which flows from bleed port, is free of air bubbles

JOB SHEET #1

d. Replace bleed screw and O ring seal and tighten securely

e. Repeat bleeding procedure with opposite cylinder

(NOTE: This may not be necessary because not all models have two cylinders.)

2. Bleed "up" side of hydraulic system

a. Loosen hose grommets from inlet cover and remove hydraulic lift cylinder from its mounts

b. Place cylinder in a horizontal position with hose ports facing up (Figure 4)

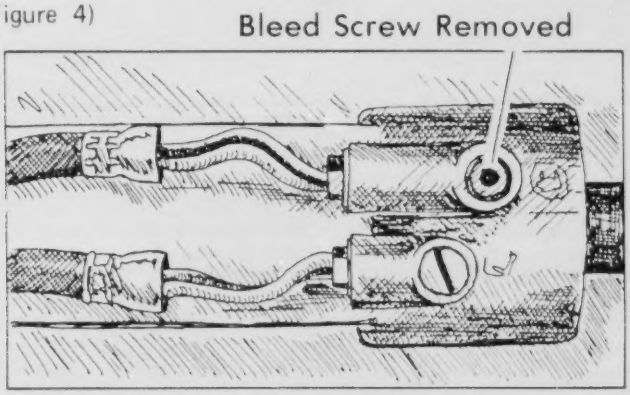


FIGURE 4

c. Remove "up" bleed screw and O ring seal from no. 1 port (Figure 4)

d. Press up/out button on the switch panel for a few seconds, release, and wait for approximately one minute

e. Repeat pumping procedure until fluid, which flows from bleed port, is free of air bubbles

f. Replace bleed screw and O ring seal and tighten securely

g. Install cylinder and hose grommets

h. Repeat bleeding procedure with opposite cylinder

(NOTE: Not all models have two cylinders.)

C. Fill pump with hydraulic fluid to appropriate level as specified in service manual

TILT ASSEMBLIES
UNIT III

JOB SHEET #2 DISASSEMBLE AND REASSEMBLE THE MANUAL TILT ASSEMBLY

I. Tools and materials

A. Hand tool assortment

B. 1/2" socket set and ratchet

C. Truarc pliers

D. Parts tray

E. Anticorrosion grease

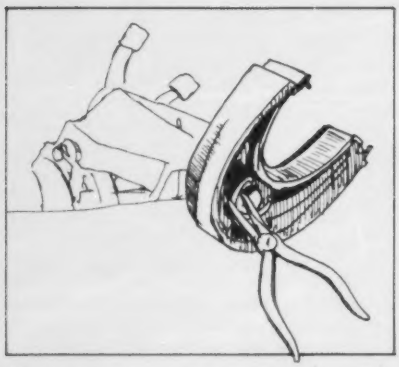
F. Appropriate service manual

II. Procedure

A. Remove exhaust housing

B. Remove nut from bottom of pivot shaft (Figures 1 and 2)

(NOTE: Some engines will have Truarc rings holding pivot shaft.)



Truarc ring removed with pliers

FIGURE 1

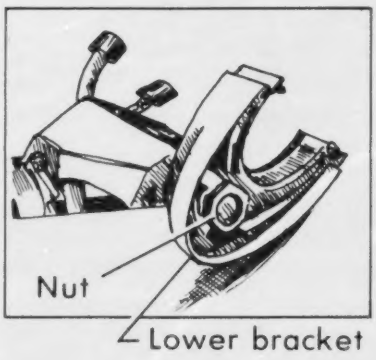


FIGURE 2

C. Remove pivot shaft, split keepers, and thrust washer (Figure 3)

(NOTE: Some pivot shafts and bracket splines have to be heated before the mount bracket can be removed from the pivot shaft.)

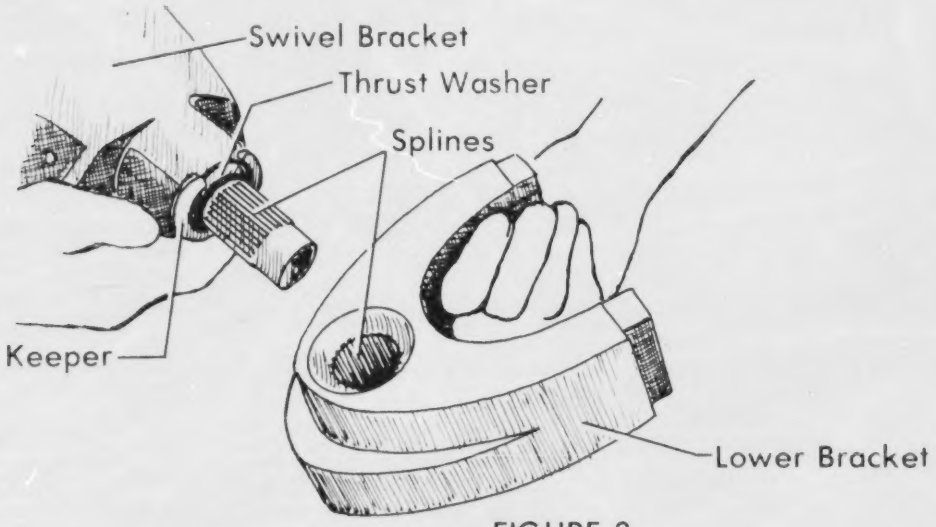


FIGURE 3

D. Drive out upper and lower seals

E. Remove bronze bushing in swivel bracket

F. Remove thrust rod, thrust spring, and retainer

G. Remove screw and plate holding port and starboard stern brackets together

H. Remove tilt tube bolt, nut, and washer from stern brackets

I. Remove shock absorbers

J. Clean parts

K. Inspect parts for damage

L. Reassemble reversing steps A through I

(NOTE: During reassembly coat spline with anticorrosion grease and torque pivot shaft nut to service manual specifications.)

TILT ASSEMBLIES
UNIT III

NAME_____

TEST

1. Match the terms on the right to the correct definitions.

_____a. Any incline of the outboard away from a vertical position	1. Transon
_____b. Remove air from a system	2. Bleed
_____c. Limits the tilt angle of the outboard	3. Tilt angle
_____d. Part of the boat from which the engine is hung	4. Limit switch
_____e. Pivot point for engine's tilt angle	5. Thrust rod
_____f. Pivot point for engine's turning radius	6. Steering arm and pivot shaft
_____g. Keeps correct engine tilt angle and locks engine tilt down during reverse operation	7. Tilt tube

2. Name two types of tilt assemblies.

a.

b.

3. Identify the parts of the hydraulic tilt assembly.

a.

b.

c.

d.

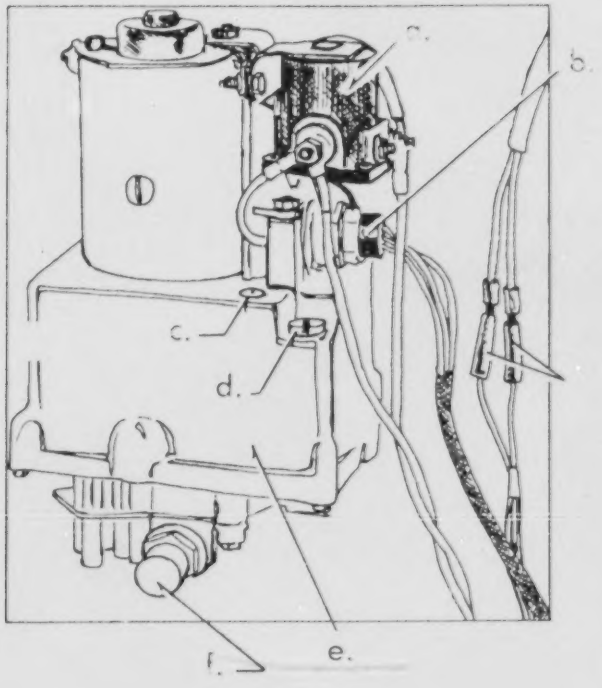
e.

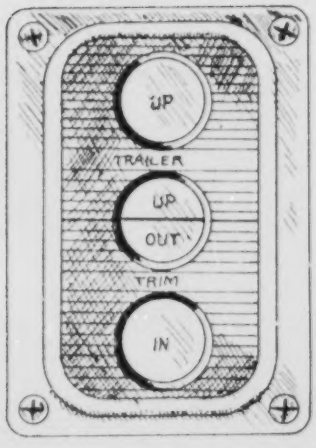
f.

g.

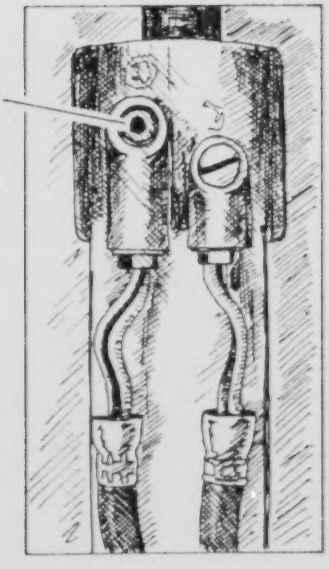
h.

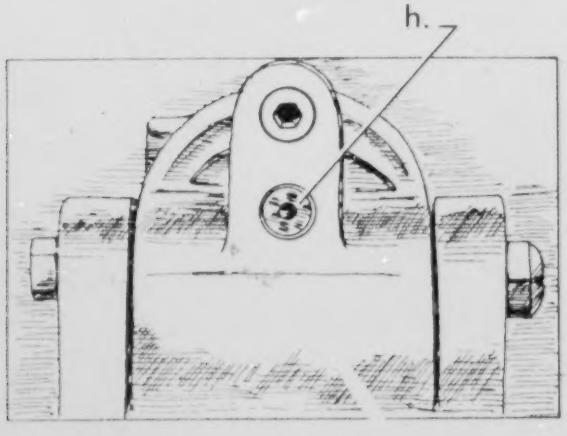
i.





g.





4. Identify the parts of the manual tilt assembly.

a.

b.

c.

d.

e.

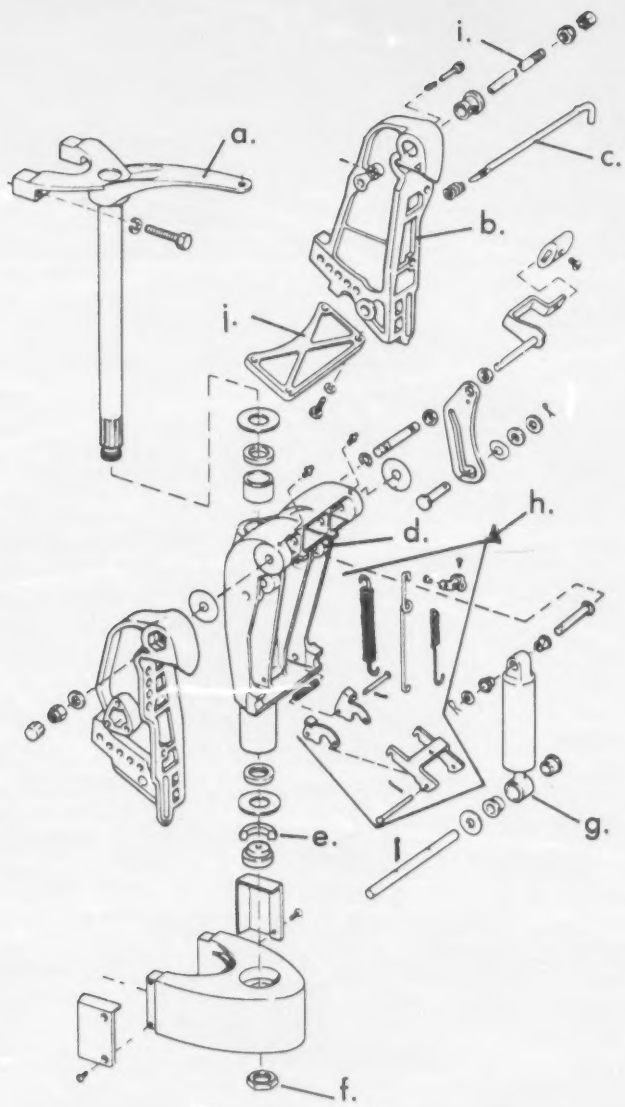
f.

g.

h.

i.

j.



5. Demonstrate the ability to:

a. Service the hydraulic tilt assembly.

b. Disassemble and reassemble the manual tilt assembly.

(NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

TILT ASSEMBLIES
UNIT III

ANSWERS TO TEST

1. a. 3
   b. 2
   c. 4
   d. 1
   e. 7
   f. 6
   g. 5

2. a. Hydraulic
   b. Manual

3. a. Solenoid
   b. Harness connector
   c. Vent screw
   d. Fill screw
   e. Hydraulic pump
   f. Control knob
   g. Switch panel
   h. Down bleed port
   i. Up bleed port

4. a. Steering arm and pivot shaft
   b. Stern brackets (port and starboard)
   c. Thrust rod
   d. Swivel bracket
   e. Keepers
   f. Nut
   g. Shock absorber
   h. Reverse lock components
   i. Tilt tube
   j. Stern bracket plate

5. Performance skills evaluated to the satisfaction of the instructor

EXHAUST HOUSING
UNIT IV

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify the parts of the exhaust housing and list the functions of the wet sleeve, exhaust relief, and exhaust housing. The student should also be able to remove, inspect, and replace the exhaust housing. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with the exhaust housing to the correct definitions.
2. Identify the parts of the exhaust housing.
3. List the functions of the wet sleeve, exhaust relief, and exhaust housing.
4. Demonstrate the ability to remove, inspect, and replace an exhaust housing.

EXHAUST HOUSING
UNIT IV

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide student with objective sheet.

B. Provide student with information and job sheets.

C. Make transparency.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Demonstrate and discuss the procedure outlined in the job sheet.

G. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Complete job sheet.

D. Complete activities assigned by instructor.

E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency master: TM 1--Parts of Exhaust Housing

D. Job Sheet #1--Remove, Inspect, and Replace an Exhaust Housing

E. Test

F. Answers to test

II. References:

A. *Johnson Outboard Motor Service Manual*. Waukegan, Illinois: Johnson Motors/Outboard Marine Corp., 1973.

B. *Mercury Marine Service Manual*. Models 1966 - 1976. Fond du Lac, Wisconsin: Mercury Marine Outboard/Brunswick Corp., 1976.

EXHAUST HOUSING
UNIT IV

INFORMATION SHEET

I. Terms and definitions

A. Wet sleeve--Area between the inner and outer exhaust housing which is full of water at all times

B. Powerhead--Engine and all its component parts

C. Shock mount--Reduces the shock between the powerhead and the exhaust housing

D. Exhaust relief--Outlet above the water line

II. Parts of the exhaust housing (Transparency 1)

A. Outer exhaust housing

B. Inner exhaust housing

C. Seal

D. Aft exhaust cover

E. Rubber mount cover

F. Rubber mount

G. Clamp

H. Mount cover

I. Water tube

III. Functions of the wet sleeve, exhaust relief, and exhaust housing

A. Wet sleeve

1. Acts as an exhaust silencer

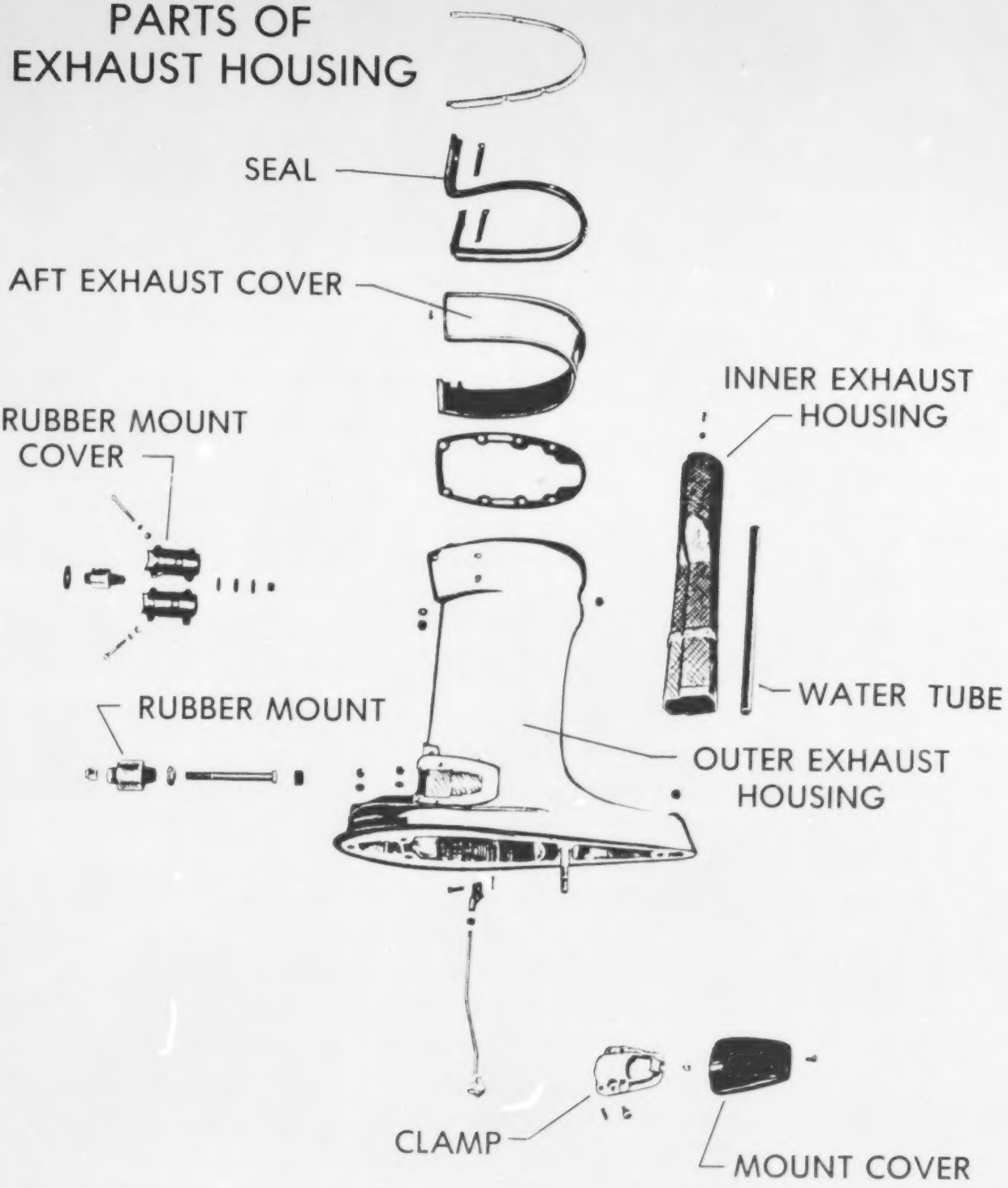
2. Cools outer exhaust housing

3. Cools lower shock mount

B. Exhaust relief--Relieves exhaust back pressure for easy starting

C. Exhaust housing--Acts as an extension so the gearcase will reach the water

PARTS OF EXHAUST HOUSING



EXHAUST HOUSING
UNIT IV

JOB SHEET #1--REMOVE, INSPECT, AND REPLACE AN EXHAUST HOUSING

I. Tools and materials

A. Hand tool assortment

B. Appropriate service manual

C. Hoist

D. Surface gauge and scriber

E. Powerhead stand

F. Lift ring

II. Procedure

A. Remove gearcase

B. Remove powerhead

1. Remove screws from aft exhaust cover and remove the cover

2. Place shift arm in neutral position

3. Disconnect battery cables from battery

4. Remove engine cover

5. Remove locknuts from top and bottom cowl support shock mounts

6. Remove fuel lines from fuel pump

7. Remove water hose from exhaust plate

8. Disconnect all electrical connections including ignition, starter solenoid, safety switch, temperature switch, choke solenoid, and stater lead

(NOTE: Disconnect electric shift control cables on electric shift models.)

JOB SHEET #1

9. Remove powerhead exhaust housing nuts (Figure 1)

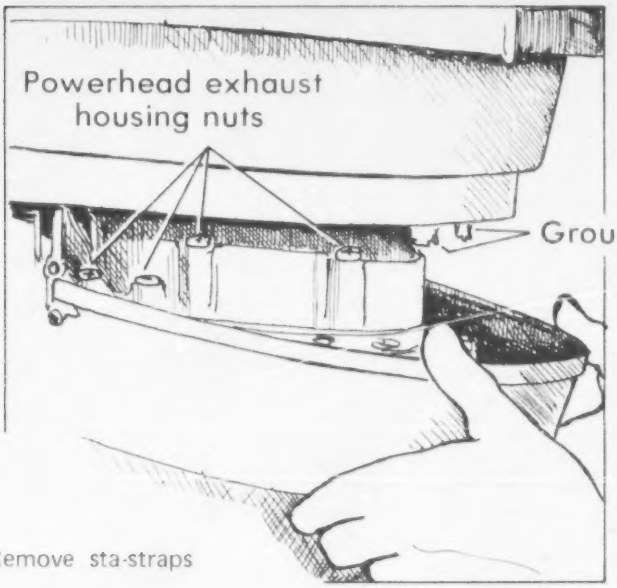


FIGURE 1

10. Remove sta-straps

11. Remove lead wires from spark plugs and lead wire retainers

12. Remove center cowl support

(NOTE: Some models do not have center cowl support.)

13. Remove plastic protector from flywheel nut and install lifting ring

(NOTE: This step is not necessary on all models because some engines already have lifting rings.)

14. Remove rear cowl support shock mount nuts and rear cowl support bracket

15. Remove shift link attaching nut

JOB SHEET #1

16. Lift powerhead and place on powerhead stand (Figure 2)

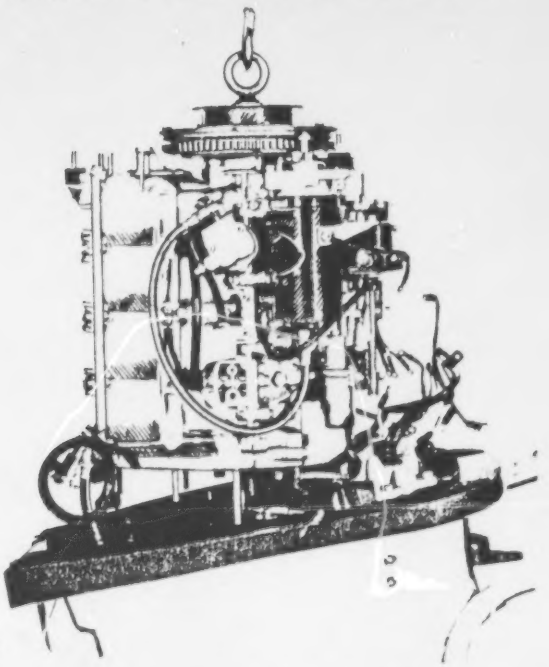


FIGURE 2

C. Remove exhaust housing

1. Remove cross pin which holds reverse lock lever in exhaust housing

(NOTE: A cross pin is not used on all models.)

2. Remove lower mount covers (Figure 3)

(CAUTION: Some covers are spring-loaded.)

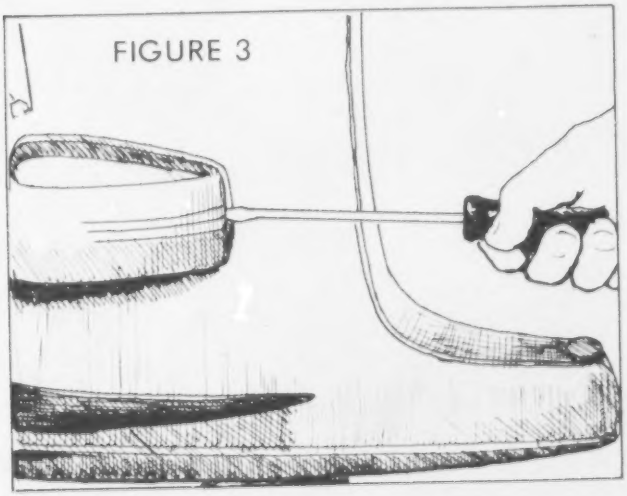


FIGURE 3

JOB SHEET #1

3. Remove nuts from lower mounting bolts (Figure 4)

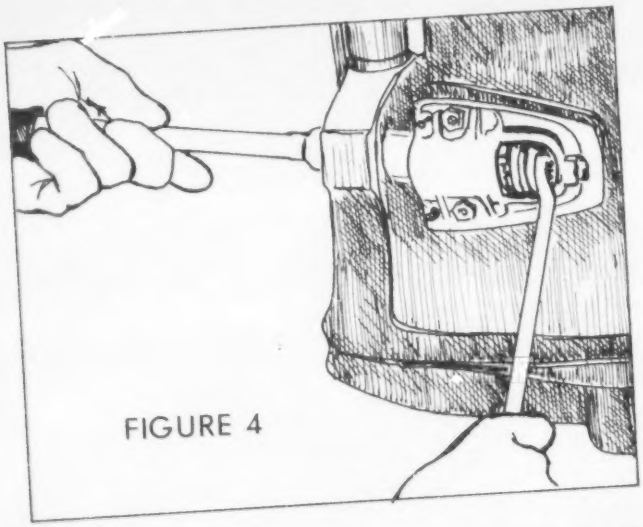


FIGURE 4

4. Remove nuts from upper yoke studs (Figure 5)

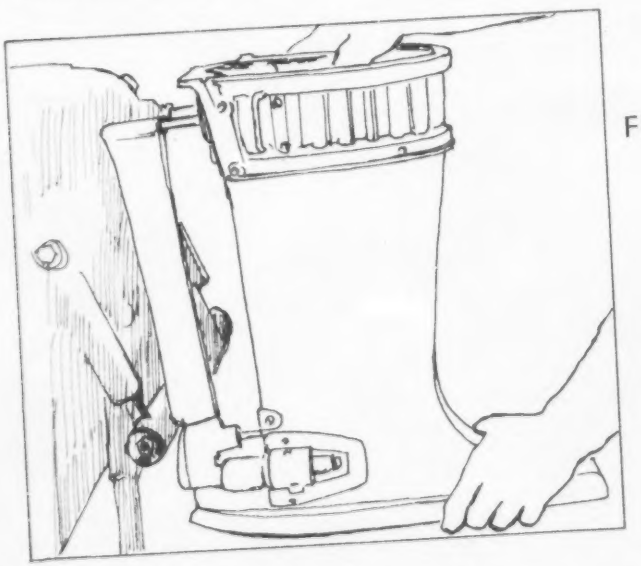


FIGURE 5

5. Remove exhaust housing by pulling from upper and lower yokes (Figure 5)

6. Clean all parts with cleaning solvent and dry

7. Inspect parts for damage

JOB SHEET #1

D. Inspect exhaust housing

1. Check exhaust housing for cracks and nicks

(NOTE: Do not attempt to weld cracks or nicks.)

2. Check parallelism of exhaust housing (Figure 6)

(NOTE: If exhaust housing is bent, replace the housing; do not attempt to straighten.)

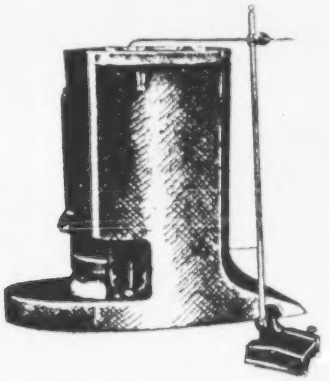


FIGURE 6

3. Check water tubes for obstructions or kinks

(NOTE: Replace these tubes as needed.)

E. Reassemble and replace by reversing procedures A through D

EXHAUST HOUSING
UNIT IV

NAME_____

TEST

1. Match the terms on the right to the correct definitions.

_____a. Outlet above the water line	1. Wet sleeve
_____b. Reduces the shock between the powerhead and the exhaust housing	2. Powerhead
_____c. Engine and all its component parts	3. Shock mount
_____d. Area between the inner and outer exhaust housing which is full of water at all times	4. Exhaust relief

2. Identify the parts of the exhaust housing.

a.

b.

c.

d.

e.

f.

g.

h.

i.

3. List the functions of the wet sleeve, exhaust relief, and exhaust housing.

   a. Wet sleeve

      1)

      2)

      3)

   b. Exhaust relief--

   c. Exhaust housing--

4. Demonstrate the ability to remove, inspect, and replace an exhaust housing.

   (NOTE: If this activity has not been accomplished prior to the test, ask your instructor when it should be completed.)

EXHAUST HOUSING
UNIT IV

ANSWERS TO TEST

1. a. 4
   b. 3
   c. 2
   d. 1
2. a. Outer exhaust housing
   b. Inner exhaust housing
   c. Seal
   d. Aft exhaust cover
   e. Rubber mount cover
   f. Rubber mount
   g. Clamp
   h. Mount cover
   i. Water tube
3. a. Wet sleeve
      1) Acts as an exhaust silencer
      2) Cools outer exhaust housing
      3) Cools lower shock mount
   b. Exhaust relief--Relieves exhaust back pressure for easy starting
   c. Exhaust housing-Acts as an extension so the gearcase will reach the water
4. Performance skill evaluated to the satisfaction of the instructor

PROPELLER AND TRIM TABS
UNIT V

UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms associated with propeller and trim tabs and identify the parts. The student should also be able to name the common types of propellers, list the kinds of materials of which they are made, list the purposes of a trim tab, and demonstrate the ability to remove, inspect, and install a propeller and a trim tab. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with propeller and trim tabs to the correct definitions.
2. Identify the parts of the propeller and the trim tab.
3. Name the two common types of propellers.
4. List the four kinds of materials used to make propellers.
5. List the purposes of the trim tab.
6. Demonstrate the ability to:
   a. Remove, inspect, and install a propeller.
   b. Remove, inspect, install, and adjust a trim tab.

PROPELLER AND TRIM TABS
UNIT V

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide student with objective sheet.

B. Provide student with information and job sheets.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Demonstrate and discuss the procedures outlined in the job sheets.

G. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Complete job sheets.

D. Complete activities assigned by instructor.

E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1--Pitch and Propeller Diameter

2. TM 2--Parts of the Propeller and the Trim Tab

D. Job sheets

1. Job Sheet #1--Remove, Inspect, and Install a Propeller

2. Job Sheet #2--Remove, Inspect, Install, and Adjust a Trim Tab

E. Test

F. Answers to test

II. References:

A. *Johnson Outboard Motor Service Manual.* Waukegan, Illinois: Johnson Motors/Outboard Marine Corp., 1973.

B. *Outboard Motor Service Manual.* Kansas City, Missouri: Abos Marine Publications Division/Intertec Publishing Corp., 1973.

C. *The R.P.M. System.* Milwaukee, Wisconsin: Evinrude Motors/Outboard Marine Corp., 1972.

D. *Mercury Marine Service Manual.* Models 1966 - 1976. Fond du Lac, Wisconsin: Mercury Marine Outboard/Brunswick Corp., 1976.

PROPELLER AND TRIM TABS
UNIT V

INFORMATION SHEET

I. Terms and definitions (Transparency 1)

A. Propeller--Device having blades for propelling a craft through the water

B. Pitch--Distance traveled in one revolution

C. Propeller diameter--Width of the circle defined by the tips of the rotating blades

D. R.P.M.--Revolution per minute

E. Torque--Twisting or rotary effect produced by a propeller

F. Starboard--Right side of a boat looking forward from the driver's seat

G. Port--Left side of a boat looking forward from the driver's seat

II. Parts of the propeller and the trim tab (Transparency 2)

A. Cotter pin

B. Spacer

C. Propeller nut

D. Propeller

E. Propeller hub

F. Thrust bushing

G. Trim tab

III. Common types of propellers

A. Two blade

B. Three blade

(NOTE: For special application, four blade and five blade propellers are used to gain greater thrust.)

INFORMATION SHEET

IV. Kinds of materials used to make propellers

A. Cast bronze

B. Cast alluminum alloy

C. Plastic

(NOTE: Plastic is used mostly on small outboards.)

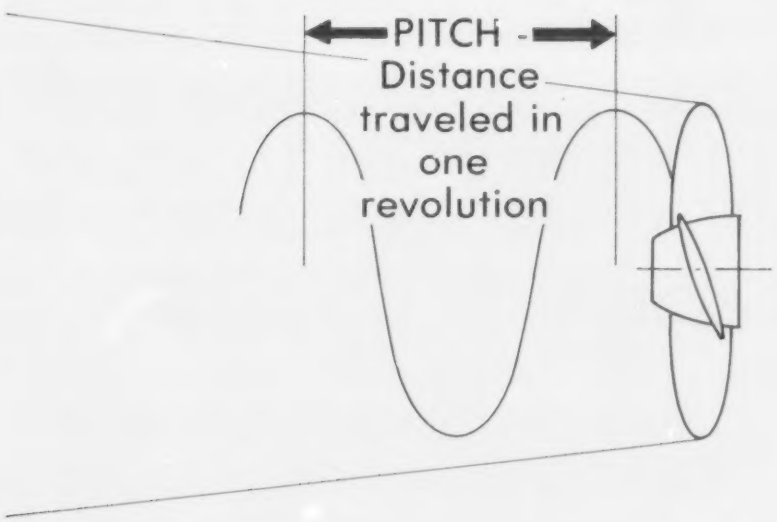
D. Stainless steel, Teflon cover (SST)

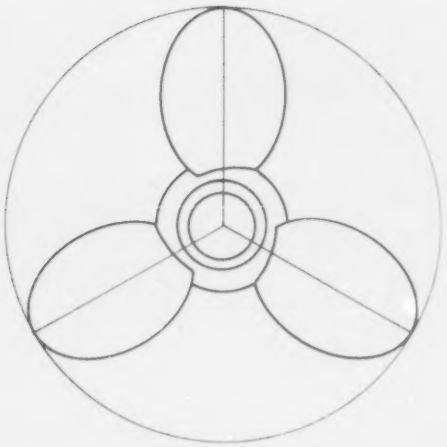
V. Purposes of the trim tab

A. Overcomes the torque of the engine

B. Helps to achieve better steering results

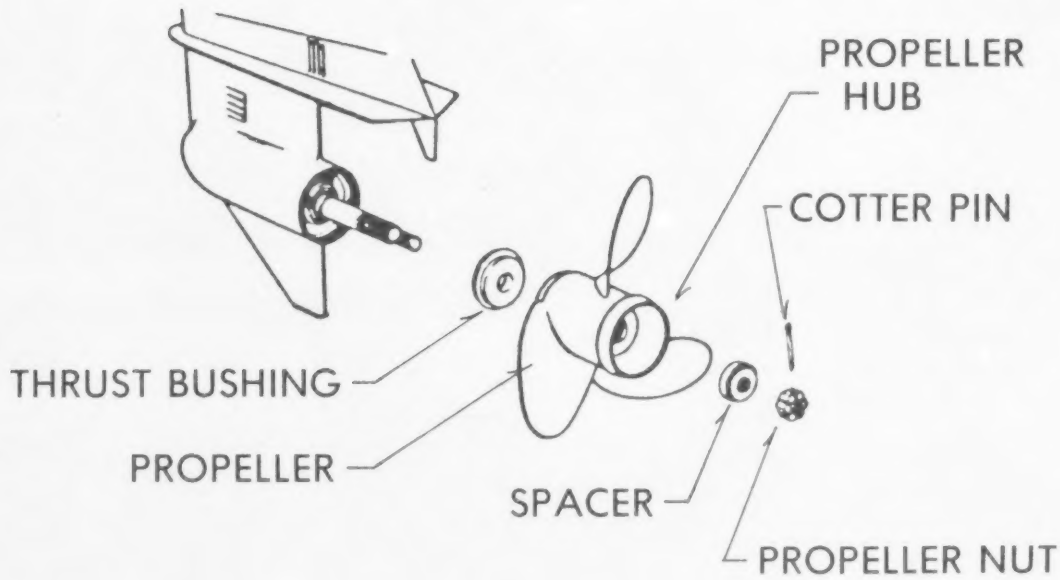
PITCH AND PROPELLER DIAMETER

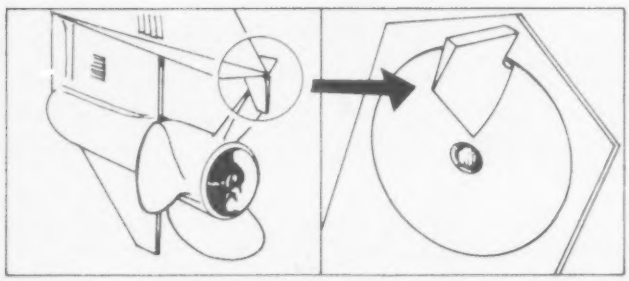




DIAMETER

PARTS OF THE PROPELLER AND TRIM TAB





PROPELLER AND TRIM TABS
UNIT V

JOB SHEET #1-REMOVE, INSPECT, AND INSTALL A PROPELLER

I. Tools and materials

A. Hand tool assortment

B. Parts tray

C. Anticorrosion grease

D. Appropriate service manual

II. Procedure

A. Put shift lever in neutral and disconnect spark plug leads from spark plugs

B. Remove cotter pin and propeller nut

(NOTE: Some propellers will be held by a shear pin.)

C. Remove propeller spacer and propeller

D. Remove thrust bushing

(NOTE: Be sure to check the position of the thrust bushing at this time.)

E. Inspect propeller for nicks, broken blades, and cracks

(NOTE: Do not attempt to weld a cracked or broken propeller.)

F. Remove minor nicks with a file

(NOTE: The aft side of the propeller is flat while the other side is rounded.)

JOB SHEET #1

G. Check rubber slip clutch using a torque wrench and compare with service manual for torque specification (Figure 1)

(NOTE: Some propellers will not have a rubber slip clutch.)

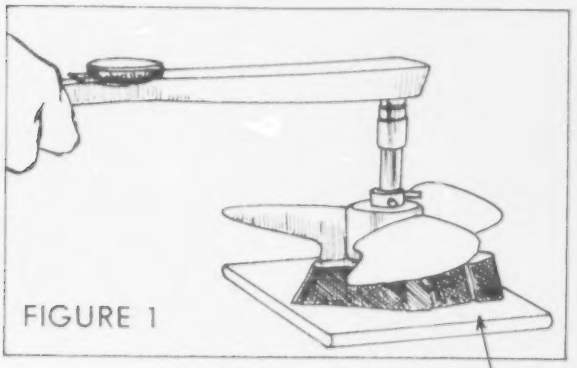


FIGURE 1

H. Lightly coat propeller shaft with anticorrosion grease

I. Install propeller reversing steps A through E

(NOTE: Check the correct position of the thrust bushing.)

PROPELLER AND TRIM TABS
UNIT V

JOB SHEET #2-REMOVE, INSPECT, INSTALL, AND ADJUST A TRIM TAB

I. Tools-Hand tool assortment

II. Procedure

A. Mark trailing edge location on cavitation plate and remove plug which is located directly above trim tab (Figure 1)

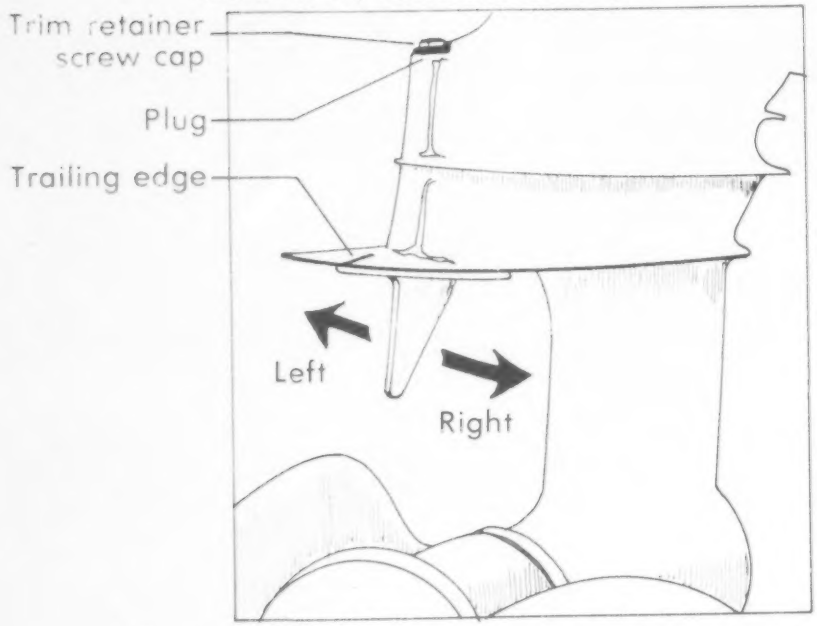


FIGURE 1

B. Remove cap and loosen screw which holds trim tab through hole in drive housing (Figure 2)

(NOTE: Some trim tab cap screws are located on the bottom.)

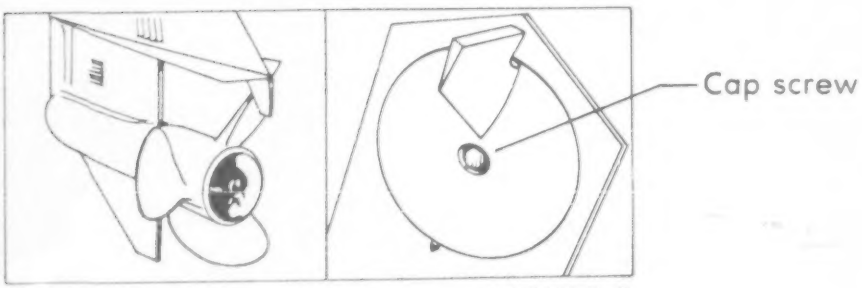


FIGURE 2

JOB SHEET #2

C. Clean recess area to assure metal-to-metal contact between drive and trim tab

(NOTE: Do not paint or place protective coating on the trim tab or its corrosion inhibiting value will be lost.)

D. Replace the trim tab if it is an anodic tab in an advanced stage of deterioration

E. Install trim tab and secure in position

F. Operate boat to desired throttle setting and turn steering wheel to left and right, noting in which direction wheel turns more easily

(NOTE: If boat performs satisfactorily, read but do not proceed on the following steps.)

(CAUTION: Put ignition in "off" position and remove keys.)

G. Loosen trim tab cap screw

H. If steering wheel turns more easily to left, position trailing edge on trim tab to left (Figure 3)

(NOTE: Make adjustments in small increments.)

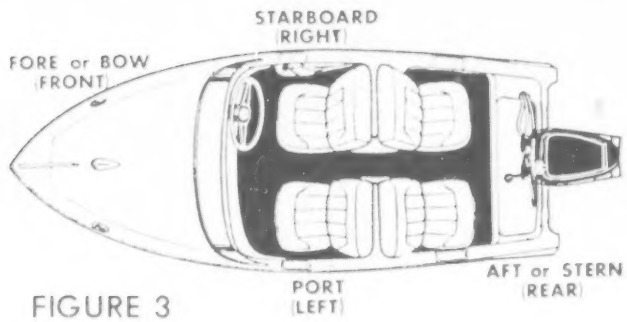


FIGURE 3

I. If steering wheel turns more easily to right, position trailing edge on trim tab to right (Figure 3)

J. Tighten cap screw

K. Operate boat to check your setting and readjust trim tab, if necessary

PROPELLER AND TRIM TAB
UNIT V

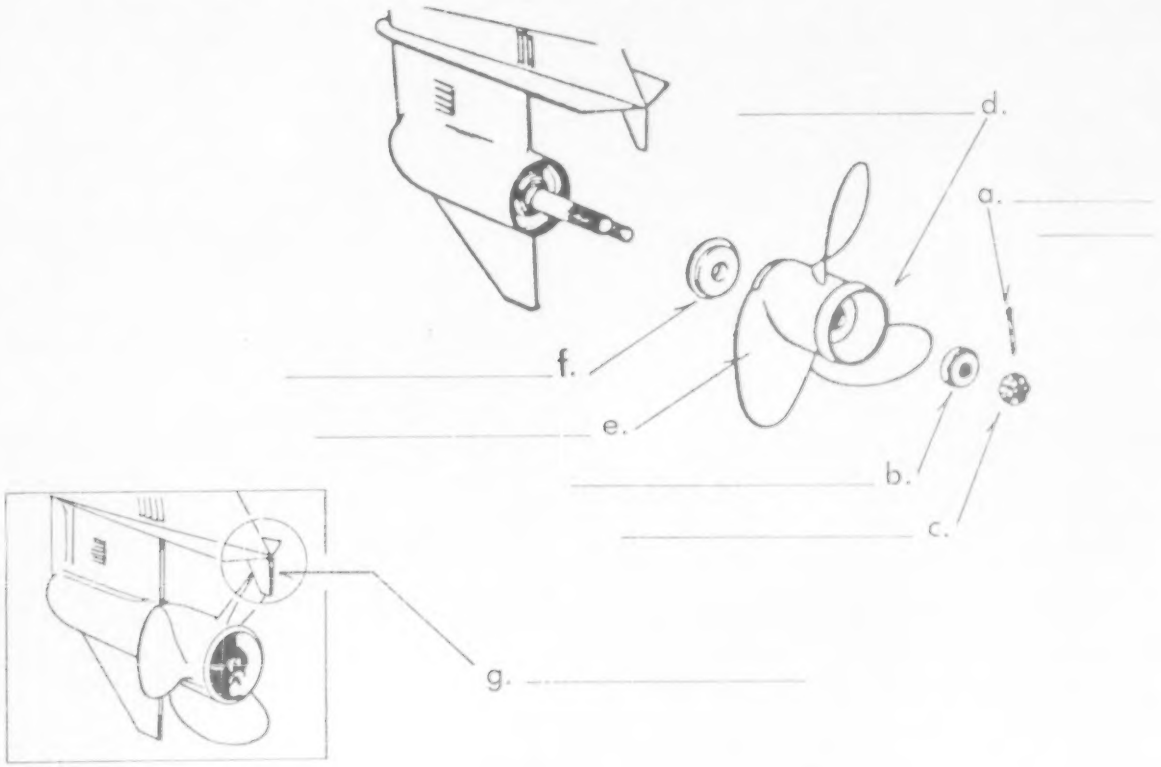
NAME _____

TEST

1. Match the terms on the right to the correct definitions.

_____	a. Width of the circle defined by the tips of the rotating blades	1.	Pitch
_____	b. Left side of a boat looking forward from the driver's seat	2.	Propeller diameter
_____	c. Twisting or rotary effect produced by a propeller	3.	Propeller
_____	d. Revolution per minute	4.	R.P.M.
_____	e. Device having blades for propelling a craft through the water	5.	Torque
_____	f. Right side of a boat looking forward from the driver's seat	6.	Starboard
_____	g. Distance traveled in one revolution	7.	Port

2. Identify the parts of the propeller and the trim tab.



3. Name the two common types of propellers.

   a.

   b.

4. List the four kinds of materials used to make propellers.

   a.

   b.

   c.

   d.

5. List the purposes of the trim tab.

   a.

   b.

6. Demonstrate the ability to:

   a. Remove, inspect, and install a propeller.

   b. Remove, inspect, install, and adjust a trim tab.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

PROPELLER AND TRIM TABS
UNIT V

ANSWERS TO TEST

1. a. 2
   b. 7
   c. 5
   d. 4
   e. 3
   f. 6
   g. 1
2. a. Cotter pin
   b. Spacer
   c. Propeller nut
   d. Propeller hub
   e. Propeller
   f. Thrust bushing
   g. Trim tab
3. a. Two blade
   b. Three blade
4. a. Cast bronze
   b. Cast aluminum alloy
   c. Plastic
   d. Stainless steel, Teflon cover (SST)
5. a. Overcomes the torque of the engine
   b. Helps to achieve better steering results
6. Performance skills evaluated to the satisfaction of the instructor

COOLING SYSTEM
UNIT VI

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify the parts of the cooling system, discuss the operation of the cooling system, and remove, inspect, and install a water pump and a thermostat. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with cooling systems to the correct definitions.
2. Identify the parts of the cooling system.
3. Identify the parts of the water pump.
4. Distinguish between impeller positions.
5. Discuss the operation of a thermostat.
6. Discuss the operation of the cooling system.
7. Demonstrate the ability to:
   a. Remove, inspect, and install a water pump.
   b. Remove, inspect, and install a thermostat.

COOLING SYSTEM
UNIT VI

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide student with objective sheet.

B. Provide student with information and job sheets.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Demonstrate and discuss the procedures outlined in the job sheets.

G. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Complete job sheets.

D. Complete activities assigned by instructor.

E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1--Parts of the Cooling System
2. TM 2--Parts of the Water Pump
3. TM 3--Water Pump Impeller Positions

4. TM 4--Operation of Thermostat

5. TM 5--Operation of Cooling System

D. Job sheets

1. Job Sheet #1--Remove, Inspect, and Install a Water Pump

2. Job Sheet #2--Remove, Inspect, and Install a Thermostat

E. Test

F. Answers to test

II. References:

A. *Johnson Outboard Motor Service Manual.* Waukegan, Illinois: Johnson Motors/Outboard Marine Corp., 1973.

B. *Outboard Motor Service Manual.* Kansas City, Missouri: Abos Marine Publications Division/Intertec Publishing Corp., 1973.

C. *Mercury Marine Service Manual.* Models 1966 - 1976. Fond du Lac, Wisconsin: Mercury Marine Outboard/Brunswick Corp., 1976.

D. Miller, Conrad. *Small Boat Engine.* New York: Sheridan House, 1970.

COOLING SYSTEM
UNIT VI

INFORMATION SHEET

I. Terms and definitions

A. Water pump--Pump located at top of gearcase and operated directly by drive shaft using centrifugal or displacement pumping action

B. Pump housing--Contains the component parts of the water pump

C. Centrifugal pumping action--High speed impeller action which centrifugally forces water into the water jacket

D. Thermostat--Automatic device for regulating temperature which opens or closes the valve controlling the flow of cooling water in the engine

E. Displacement pumping action--Low speed impeller action which displaces water by each rotation of impeller

F. Water tube--Tube that transfers the water from the water pump to the engine water jackets

G. Water jacket--Outer casing around the engine cylinders that forms a space permitting the circulation of water for cooling purposes

II. Parts of the cooling system (Transparency 1)

A. Water jacket

B. Pressure control valve

C. Thermostat

D. Water outlet

E. Water by pass tube

F. Water intake

G. Water pump

III. Parts of the water pump (Transparency 2)

A. Pump housing

B. Insert

C. Impeller

INFORMATION SHEET

D. Impeller drive pin

E. Gaskets

F. Face plate

IV. Impeller positions (Transparency 3)

A. Low speed--Impeller works as a displacement pump

B. High speed--Impeller works as a centrifugal pump

V. Operation of the thermostat (Transparency 4)

A. When the engine is cold, the thermostat shuts off the flow of water from the engine to the lake to allow quicker engine warm-up

B. When the engine is at operating temperature, the thermostat is open and allows the water to circulate through the system

VI. Operation of the cooling system (Transparency 5)

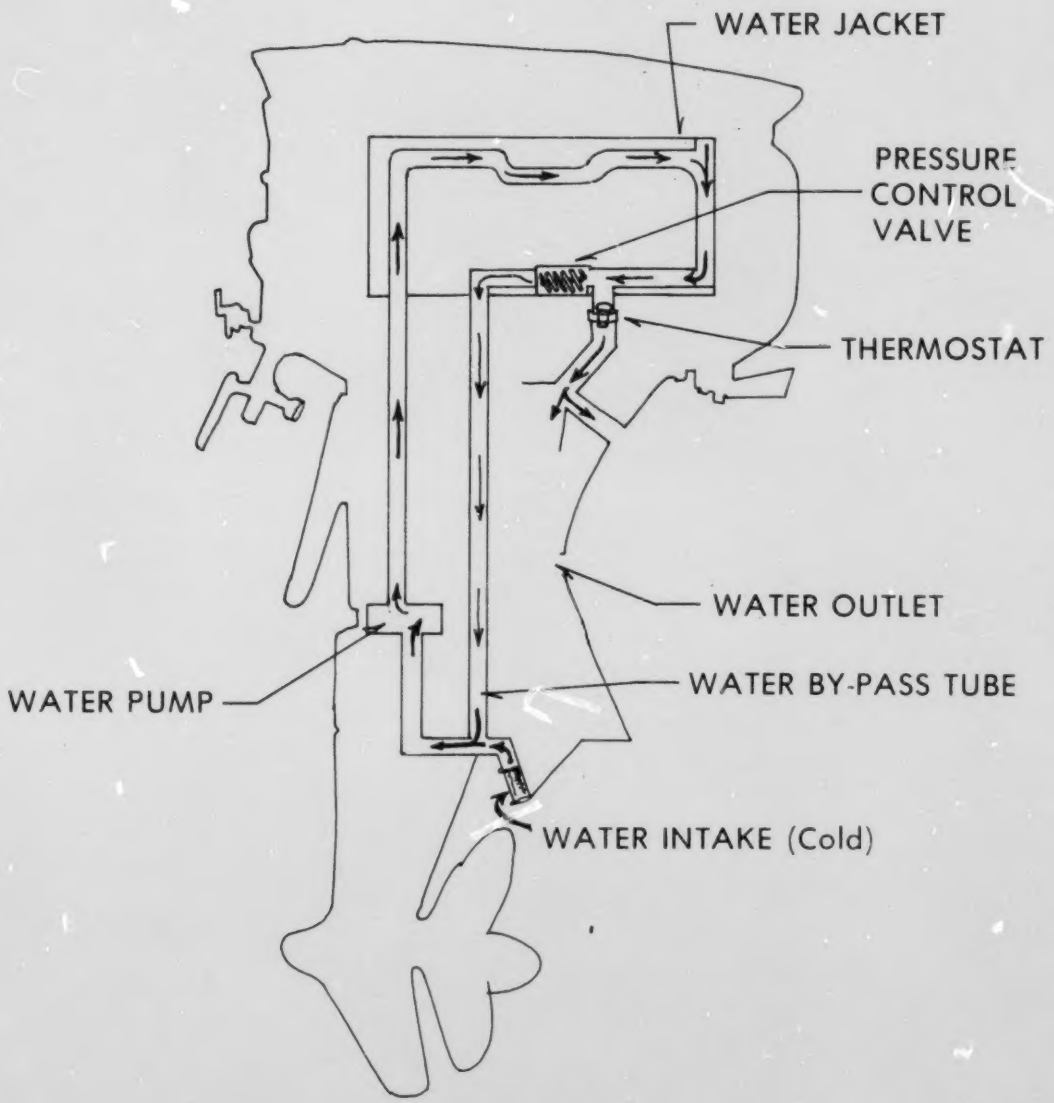
A. Water pump pulls water from the lake

B. Water pump forces water up to the engine

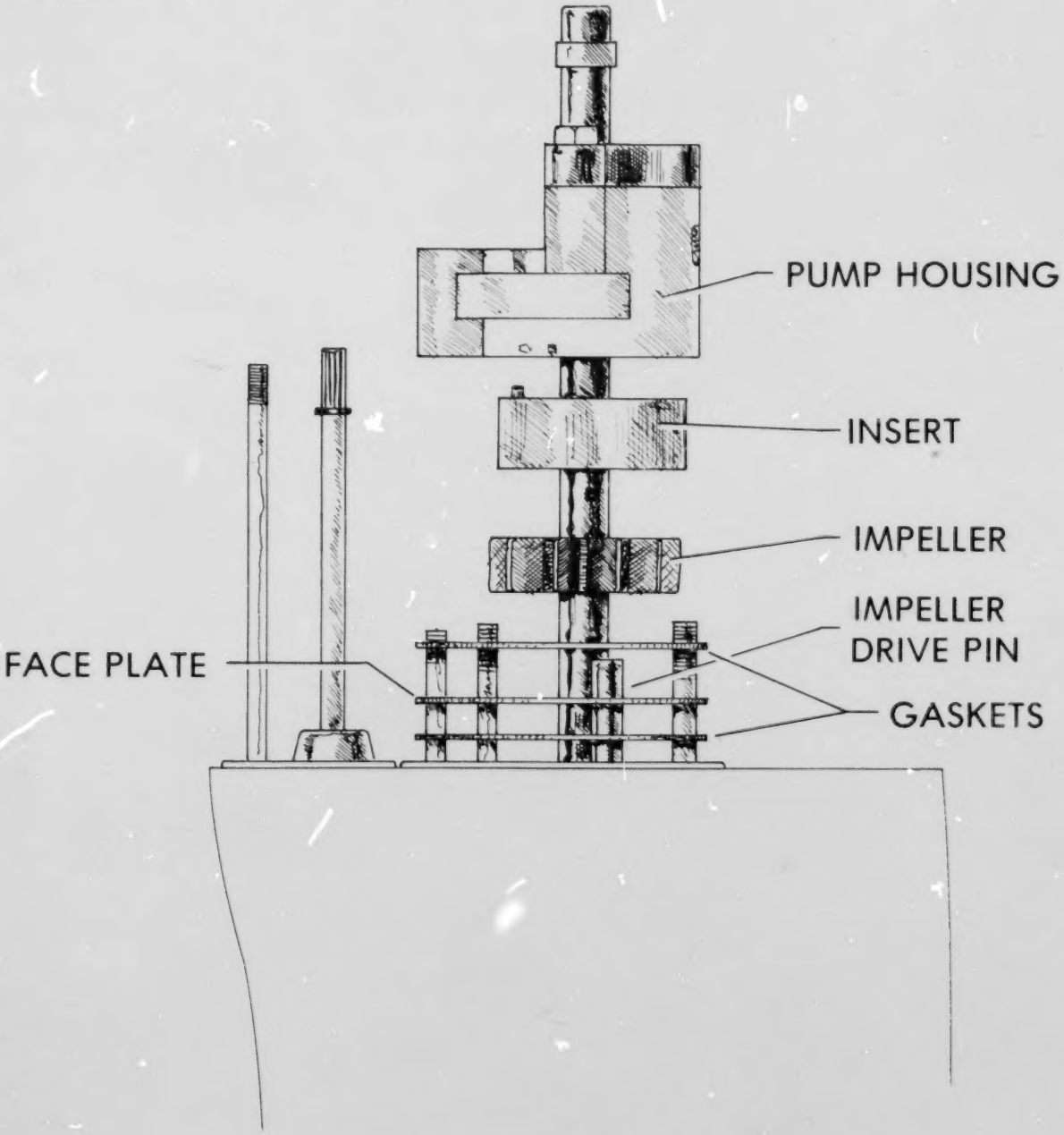
C. Water is circulated through the water jackets

D. Water is pushed out the outlet and back into the lake

PARTS OF THE COOLING SYSTEM



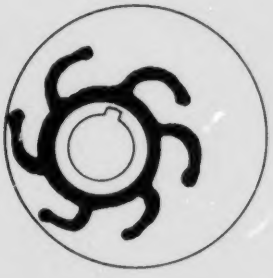
PARTS OF THE WATER PUMP



WATER PUMP IMPELLER POSITIONS

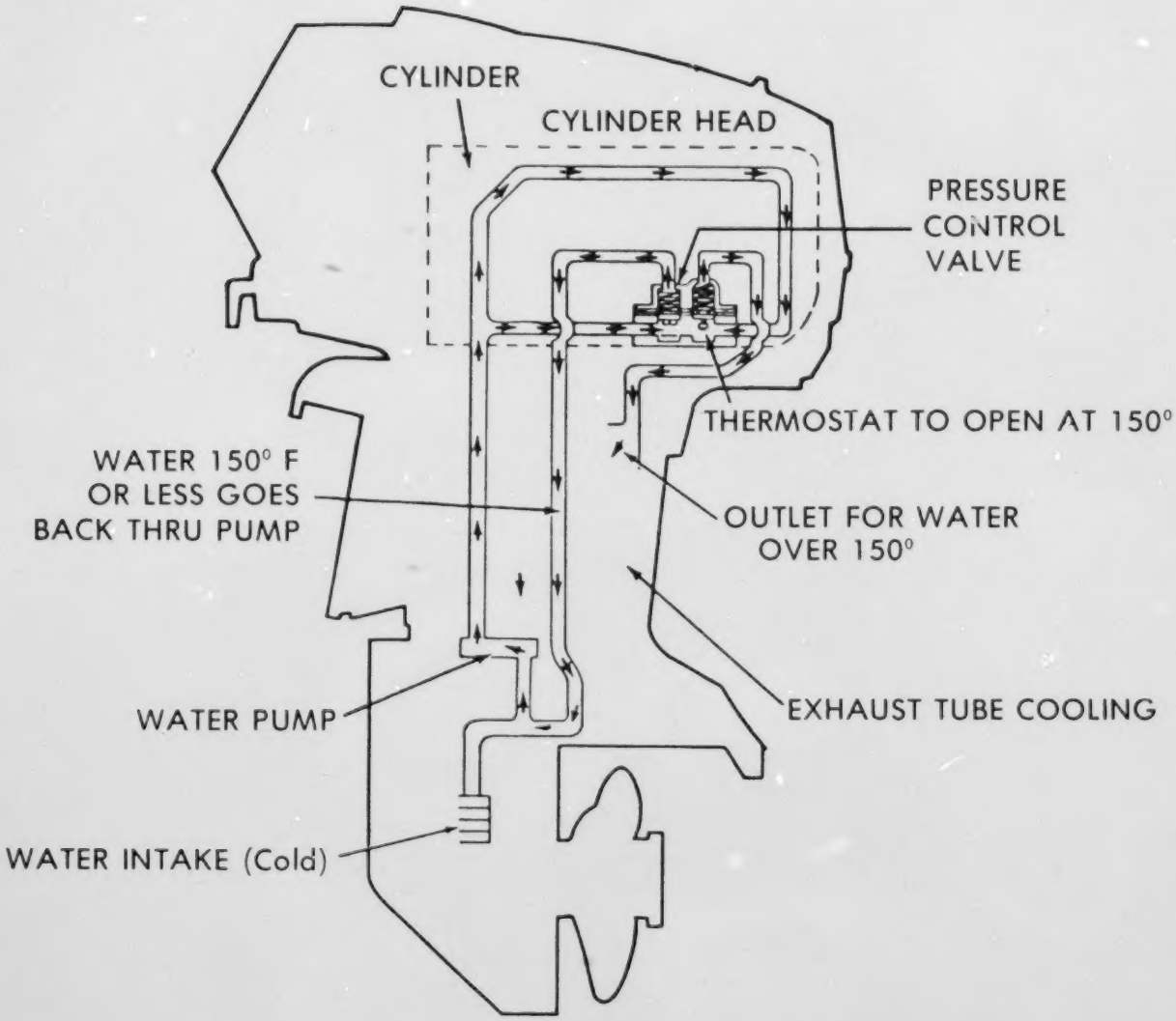
IMPELLER AT

LOW SPEED

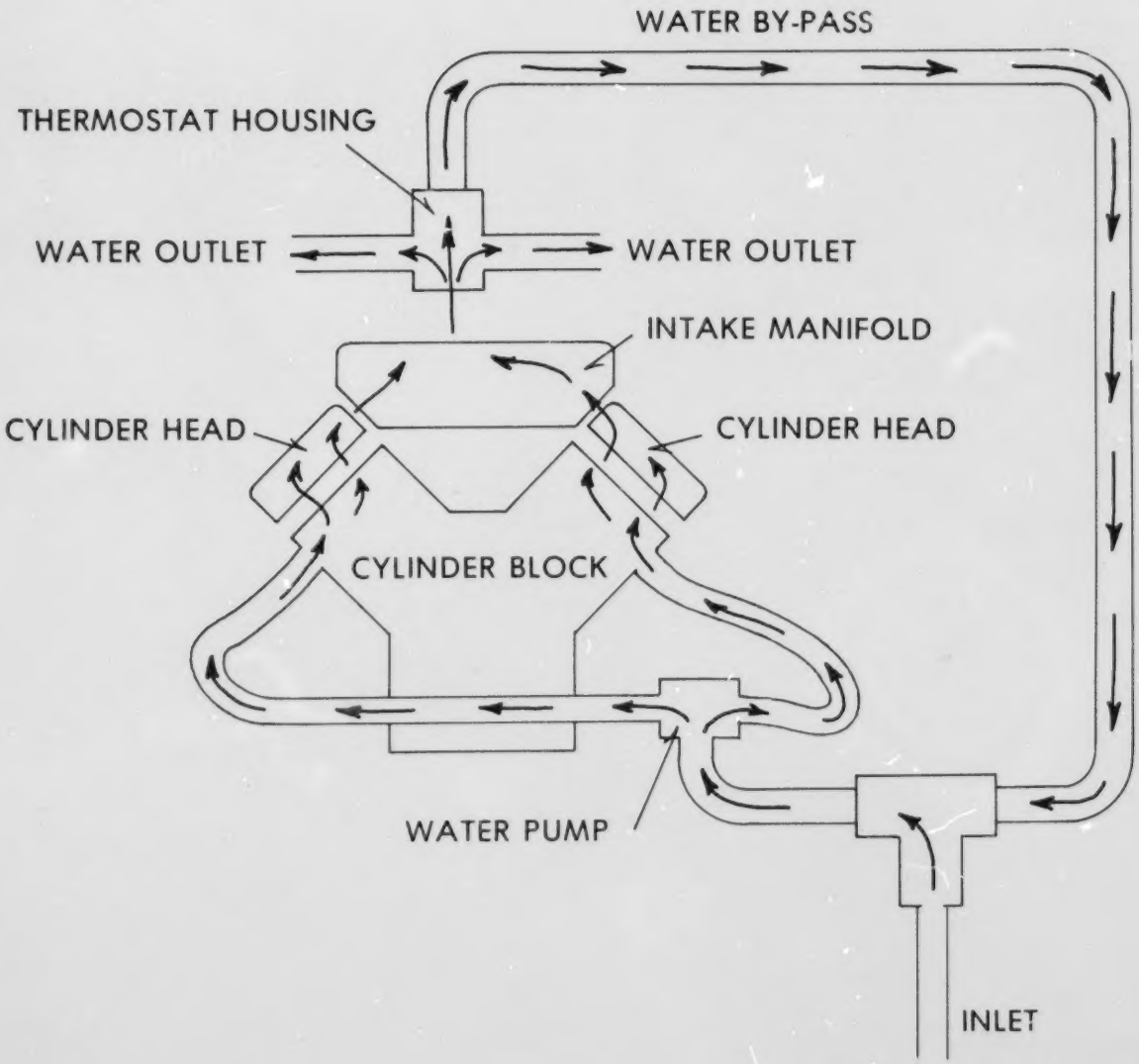


HIGH SPEED

OPERATION OF THERMOSTAT



OPERATION OF COOLING SYSTEM



COOLING SYSTEM
UNIT VI

L

JOB SHEET #1--REMOVE, INSPECT, AND INSTALL A WATER PUMP

I. Tools and materials

A. Hand tool assortment

B. Gasket sealer

C. Torque wrench

D. Parts tray

E. Appropriate service manual

II. Procedure

A. Disconnect spark plug wires from plugs

B. Remove inspection plate from exhaust housing to expose shift rod connector, and remove lower connector screw (Figure 1)

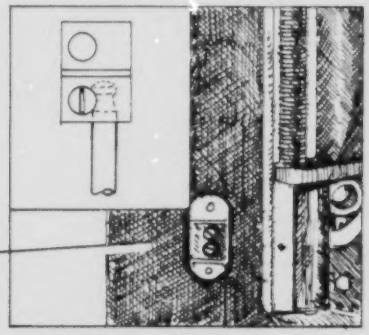


FIGURE 1

C. Disconnect shift rod

(NOTE: On engines that have electric start it may be necessary to remove starter and then shift rod.)

D. Scribe a mark on gearcase across to adjustable trim tab so it can be reinstalled in the same position

JOB SHEET #1

E. Remove retaining screw and adjustable trim tab (Figure 2)

(NOTE: On some models it is not necessary to remove trim tab.)

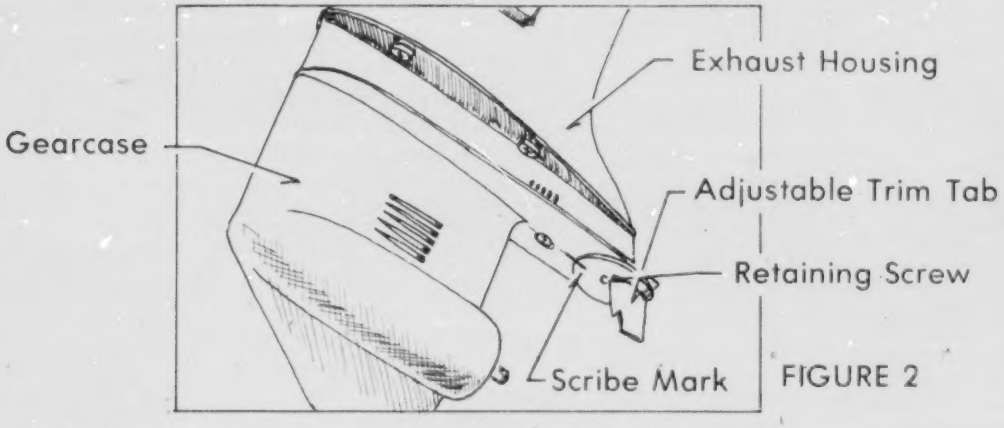


FIGURE 2

F. Remove screws attaching gearcase to exhaust housing, and remove the gearcase (Figure 3)

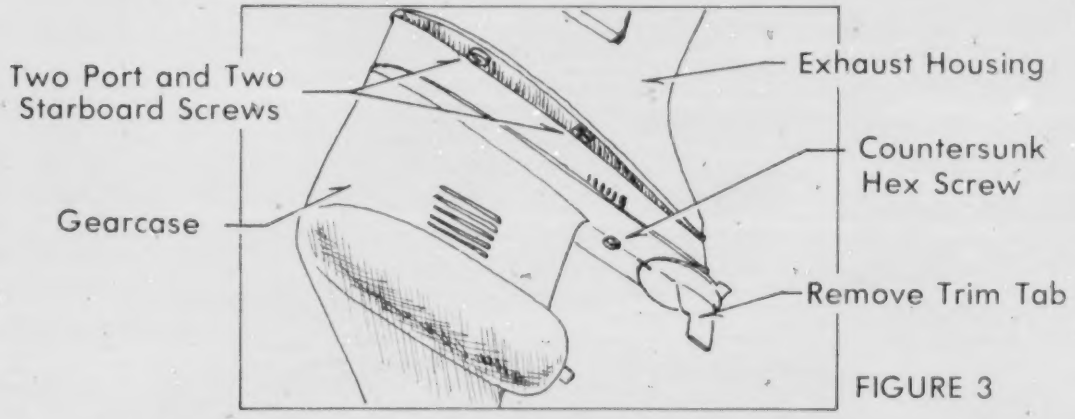


FIGURE 3

G. Remove pump housing screws (Figure 4)

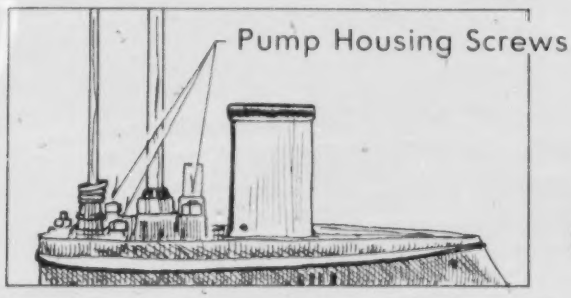


FIGURE 4

JOB SHEET #1

H. Slide pump housing and impeller off drive shaft (Figure 5)

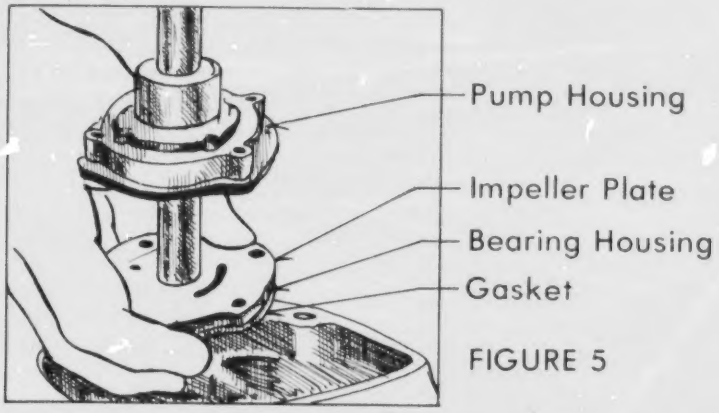


FIGURE 5

I. Clean for reassembly

J. Inspect parts for wear or damage

K. Reassemble and replace by reversing steps A through H

COOLING SYSTEM
UNIT VI

JOB SHEET #2 REMOVE, INSPECT, AND INSTALL A THERMOSTAT

I. Tools and materials

A. Hand tool assortment

B. Gasket sealer

C. Torque wrench

D. Parts tray

E. Appropriate service manual

F. 125°F thermomelt stick

G. 163°F thermomelt stick

H. Test tank

II. Procedure

A. Install outboard in test tank

B. Remove engine cover

C. Run engine until it reaches normal operating temperature

D. Check engine temperature with thermomelt stick (Figure 1)

(NOTE: After engine reaches normal operating temperature, a 125°F. stick should melt, but a 163°F. stick should not melt. If the cooling system does not meet the specification, the thermostat should be replaced.)

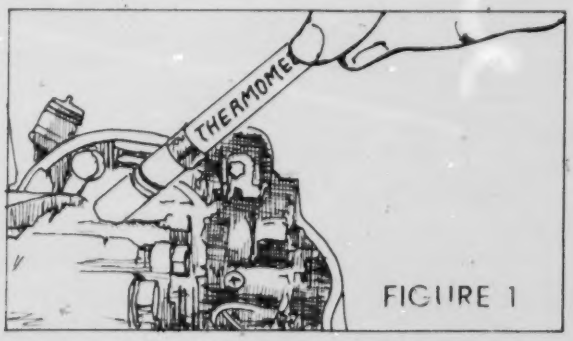


FIGURE 1

JOB SHEET #2

E. Remove hose connected to thermostat outlet, if required

F. Remove the thermostat cover retaining bolts

(CAUTION: Some thermostat covers have spring pressure.)

G. Remove thermostat control unit from the cover

(NOTE: The thermostat control unit cannot be serviced. The thermostat control unit should be replaced if questionable.)

H. Inspect pressure valve, valve seats, and gasket for leakage (Figure 2)

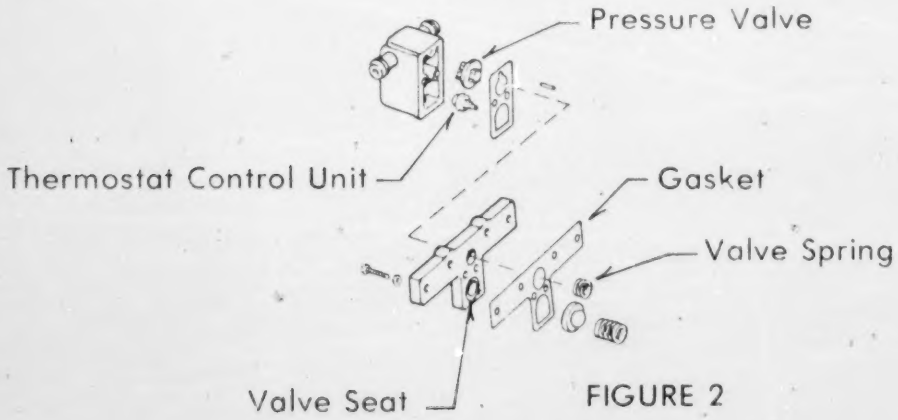


FIGURE 2

I. Reassemble and install by reversing steps E through H

COOLING SYSTEM
UNIT VI

NAME_____

TEST

1. Match the terms on the right to the correct definitions.

_____a. Automatic device for regulating temperature which opens or closes the valve controlling the flow of cooling water in the engine

_____b. Low speed impeller action which displaces water by each rotation of impeller

_____c. Pump located at top of gearcase and operated directly by drive shaft using centrifugal or displacement pumping action

_____d. Tube that transfers the water from the water pump to the engine water jackets

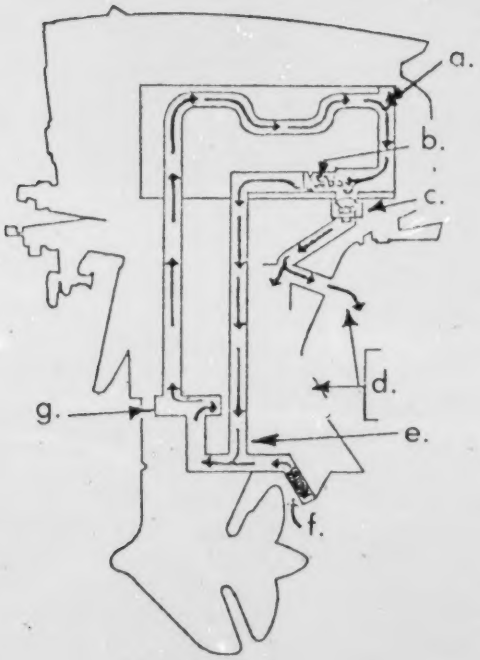
_____e. High speed impeller action which centrifugally forces water into the water jacket

_____f. Outer casing around the engine cylinders that forms a space permitting the circulation of water for cooling purposes

_____g. Contains the component parts of the water pump

1. Water pump
2. Pump housing
3. Centrifugal pumping action
4. Thermostat
5. Displacement pumping action
6. Water tube
7. Water jacket

2. Identify the parts of the cooling system.



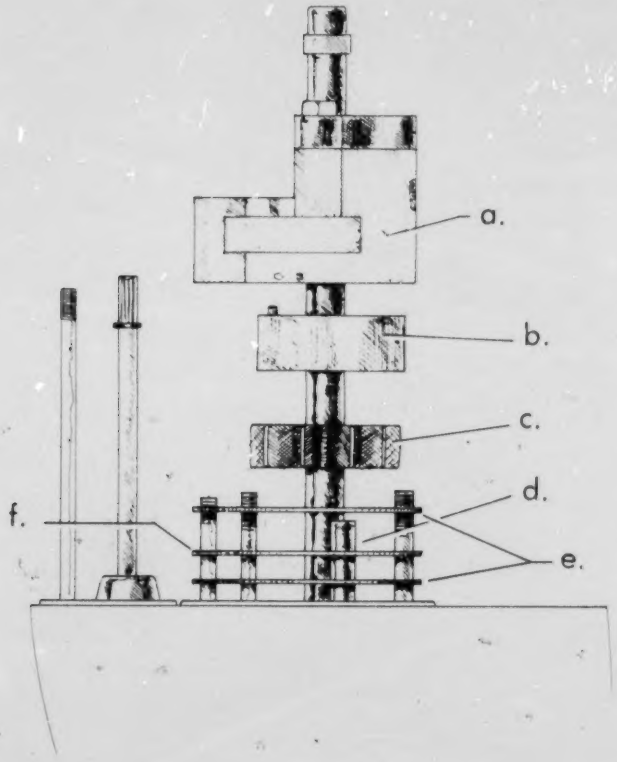
a. _____ e. _____

b. _____ f. _____

c. _____ g. _____

d. _____

3. Identify the parts of the water pump.



a. _____ d. _____

b. _____ e. _____

c. _____ f. _____

4. Distinguish between the impeller positions by placing an "X" next to the picture of the high speed impeller position.

a. _____ b. _____

5. Discuss the operation of a thermostat.

6. Discuss the operation of the cooling system.

7. Demonstrate the ability to:

   a. Remove, inspect, and install a water pump.

   b. Remove, inspect, and install a thermostat.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

COOLING SYSTEM
UNIT VI

ANSWERS TO TEST

1. a. 4
   b. 5
   c. 1
   d. 6
   e. 3
   f. 7
   g. 2

2. a. Water jacket
   b. Pressure control valve
   c. Thermostat
   d. Water outlet
   e. Water by-pass tube
   f. Water intake
   g. Water pump

3. a. Pump housing
   b. Insert
   c. Impeller
   d. Impeller drive pin
   e. Gaskets
   f. Face plate

4. b

5. Discussion should include:

   a. When the engine is cold, the thermostat shuts off the flow of water from the engine to the lake to allow quicker engine warm-up

   b. When the engine is at operating temperature, the thermostat is open and allows the water to circulate through the system

6. Discussion should include:

   a. Water pump pulls water from the lake

   b. Water pump forces water up to the engine

   c. Water is circulated through the water jackets

   d. Water is pushed out the outlet and back into the lake

7. Performance skills evaluated to the satisfaction of the instructor

MECHANICAL GEARCASE
UNIT VII

UNIT OBJECTIVE

After completion of this unit, the student should be able to match the terms to the definitions and identify the parts of a mechanical gearcase. The student should also be able to state the purposes of the main parts and demonstrate the ability to disassemble, reassemble, and service a one-piece and a two-piece mechanical gearcase. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with the mechanical gearcase to the correct definitions.
2. Identify the parts of a mechanical gearcase.
3. State the purposes of the main parts of the mechanical gearcase.
4. Demonstrate the ability to:
   a. Disassemble, reassemble, and service a one-piece mechanical gearcase.
   b. Disassemble, inspect, reassemble, and service a two-piece mechanical gearcase.

MECHANICAL GEARCASE
UNIT VII

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide student with objective sheet.

B. Provide student with information and job sheets.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Demonstrate and discuss the procedures outlined in the job sheets.

G. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Complete job sheets.

D. Complete activities assigned by instructor.

E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1--Drive Shaft and Shift Shaft

2. TM 2--Propeller Shaft

D. Job sheets

1. Job Sheet #1--Disassemble, Reassemble, and Service a One-Piece Mechanical Gearcase

2. Job Sheet #2--Disassemble, Inspect, Reassemble, and Service a Two-Piece Mechanical Gearcase

E. Test

F. Answers to test

II. References:

A. *Mercury Marine Service Manual.* Models 1966 - 1976. Fond du Lac, Wisconsin: Mercury Marine Outboard/Brunswick Corp., 1976.

B. *Outboard Motor Service Manual.* Vol. 2. 6th ed. Kansas City, Missouri: Abos Marine Publication Division/Intertec Publishing Corp., 1973.

MECHANICAL GEARCASE
UNIT VII

INFORMATION SHEET

I. Terms and definitions

A. Dog clutch--Mating collars or flanges with projecting lugs or fingers which interlock when engaged

(NOTE: This is sometimes called a sliding clutch.)

B. Gearcase--Housing containing the parts of the transmission

C. Backlash--Motion between a driving part and a driven part which does not cause motion of the driven part

(NOTE: This is also called lost motion or clearance between two mating surfaces.)

D. Pinion gear--Gear on the end of the drive shaft

E. Shims--Thin sheets used as spacers between two parts

F. Thrust washer--Bronze or hardened steel washer placed between two moving parts

II. Main parts of a mechanical gearcase (Transparencies 1 and 2)

A. Gearcase

B. Shift shaft

C. Reverse locking cam

D. Bearings

E. Drive shaft

F. Pinion gear

G. Shift cam

H. Cam follower

I. Tapered roller bearing assembly

INFORMATION SHEET

J. Forward gear assembly

K. Cross pin

L. Retaining ring

M. Dog clutch

N. Propeller shaft

O. Reverse gear

P. Thrust washer

Q. Bearing carrier assembly

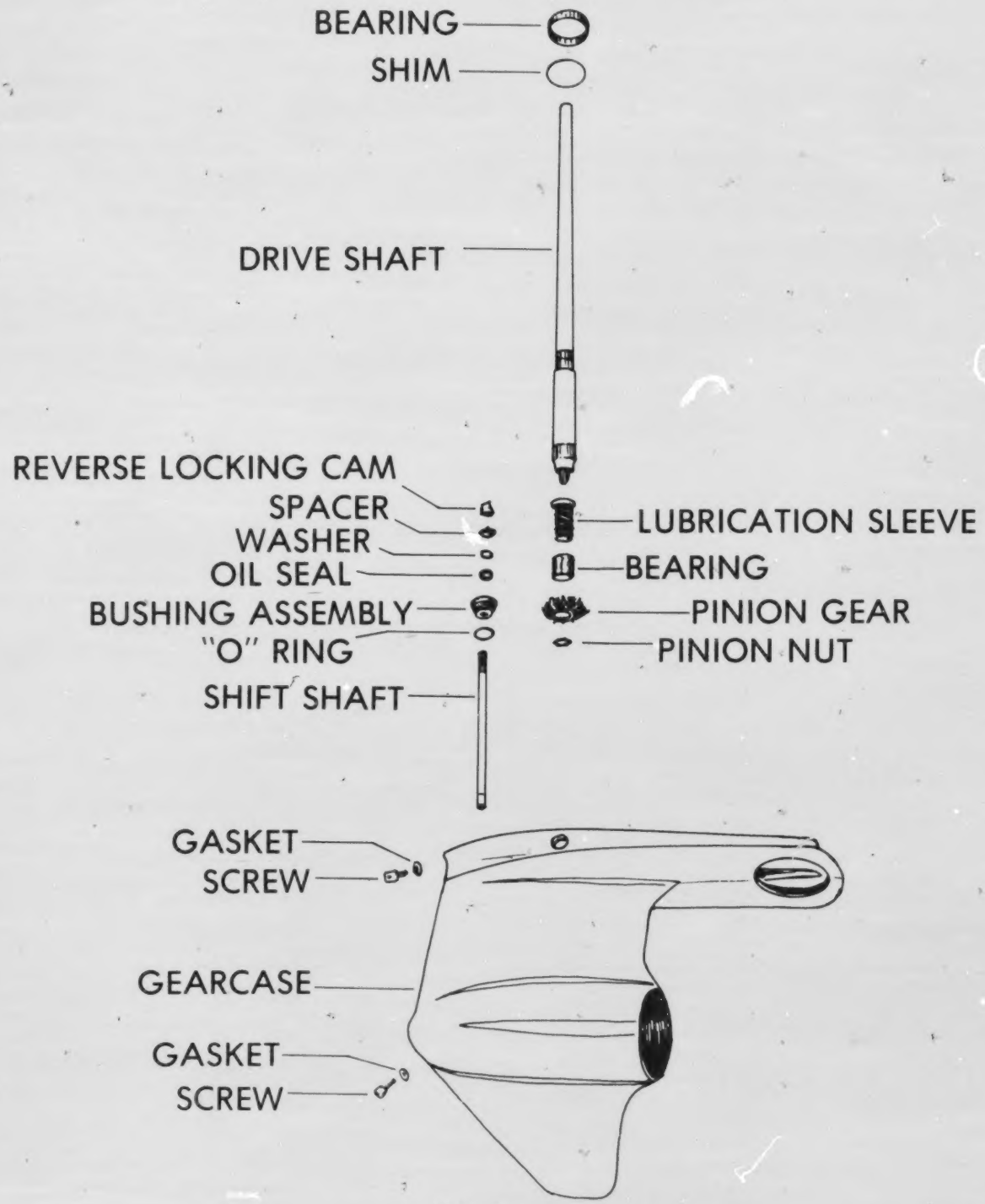
III. Purposes of the main parts of the mechanical gearcase

A. Shafts--Transmit the power from the engine to the propeller

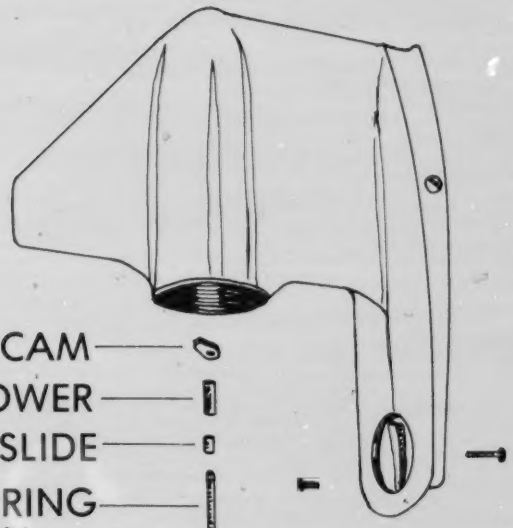
B. Gear and bearing assemblies--Transform the rotary energy of the drive shaft into forward motion of the boat

C. Seals--Retain lubrication and prevent water from entering gear housing

DRIVE SHAFT AND SHIFT SHAFT



PROPELLER SHAFT



SHIFT CAM
CAM FOLLOWER
CROSS PIN SLIDE
COMPRESSION SPRING
SHIM
THRUST WASHER
BEARING
"O" RING
BEARING
BEARING CARRIER ASSEMBLY
OIL SEAL
TAB WASHER
GEAR HOUSING COVER
THRUST HUB
CUP WASHER
SPLINED WASHER
TAB WASHER
PROPELLER NUT
TAPERED ROLLER BEARING ASSEMBLY
BEARING
FORWARD GEAR ASSEMBLY
CROSS PIN
RETAINING RING
DOG CLUTCH
PROPELLER SHAFT
REVERSE GEAR ASSEMBLY
SHIM

TM 2

MECHANICAL GEARCASE
UNIT VII

JOB SHEET #1 DISASSEMBLE, REASSEMBLE, AND SERVICE
A ONE-PIECE MECHANICAL GEARCASE

I. Tools and materials

A. Parts tray

B. Appropriate service manual

C. Hand tool assortment

D. Gear puller

E. Bench vise

F. Two blocks of wood

G. Recommended gear lubricant

H. Gearcase leak tester

I. Spanner wrench

II. Procedure

A. Remove propeller shaft

1. Drain lubricant from gearcase by removing grease filler hole screw and air vent hole screw (Figure 1)

(NOTE: Do not lose washer.)

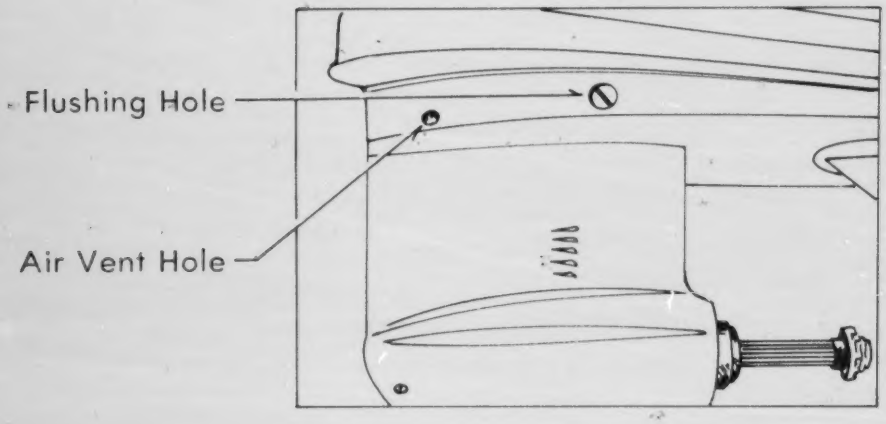


FIGURE 1

JOB SHEET #1

2. Replace washer and screws after draining

3. Remove propeller

4. Remove gearcase assembly from exhaust housing

5. Set gearcase in vise in upright position with skeg held between blocks of wood (Figure 2)

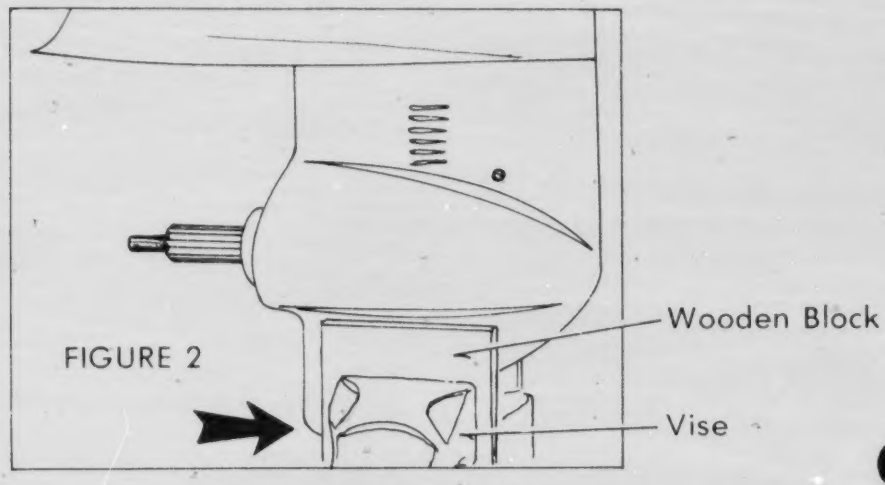


FIGURE 2

6. Remove water pump

7. Check backlash between gear (Figure 3)

(NOTE: Backlash should meet service manual specification; if not, shimming will be required during reassembly.)

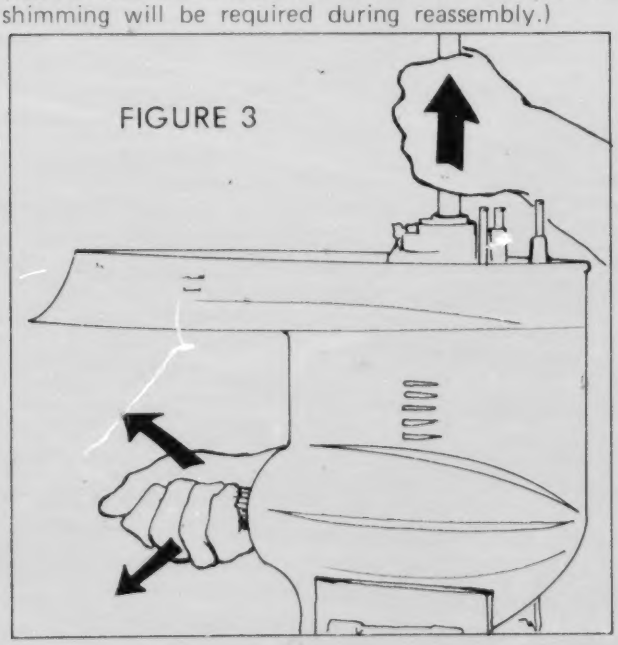


FIGURE 3

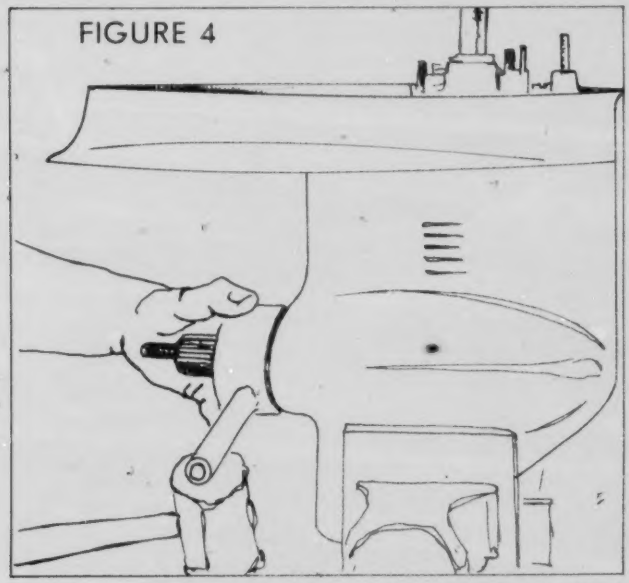
JOB SHEET #1

8. Bend tab or tab washer

9. Remove gearcase cover washer (Figure 4)

(NOTE: Some gearcase covers are left-hand thread, and some gearcases do not have covers but are positioned by two large truarc rings.)

FIGURE 4



10. Place propeller shaft in vise between two pieces of wood and remove bearing carrier assembly (Figure 5)

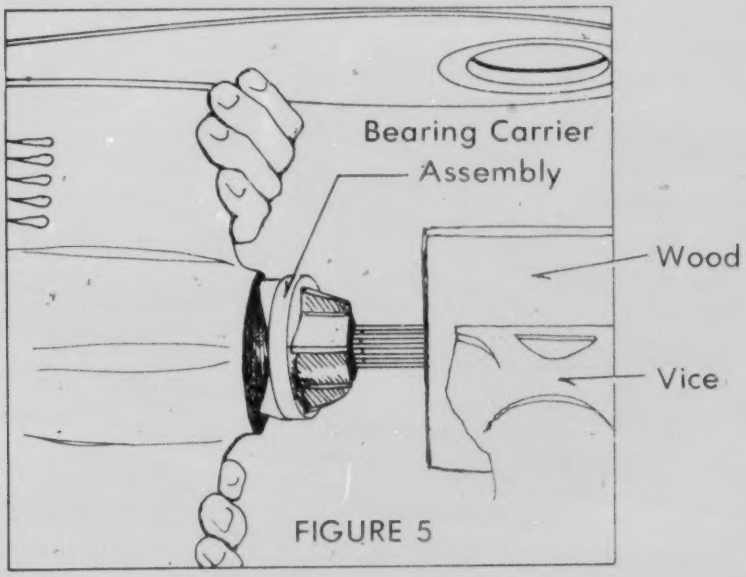


FIGURE 5

11. Remove reverse gear assembly and ball bearing from bearing carrier assembly (Figure 6)

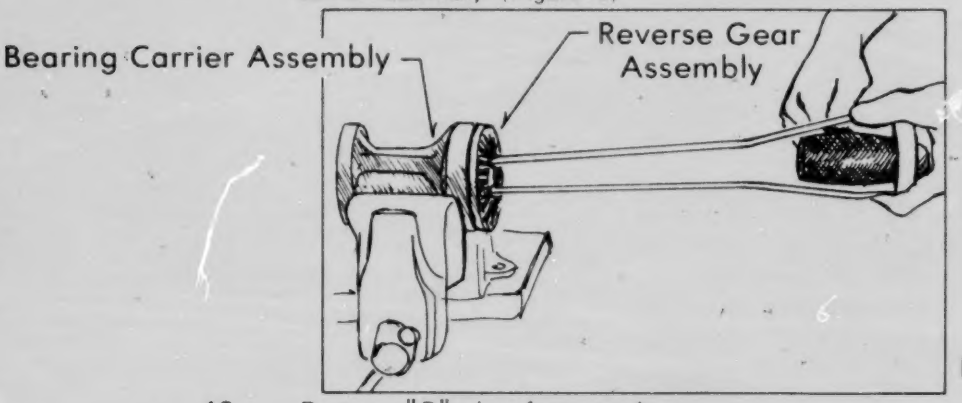


FIGURE 6

12. Remove "O" ring from carrier

13. Press or tap roller bearing and seal from carrier (Figure 7)

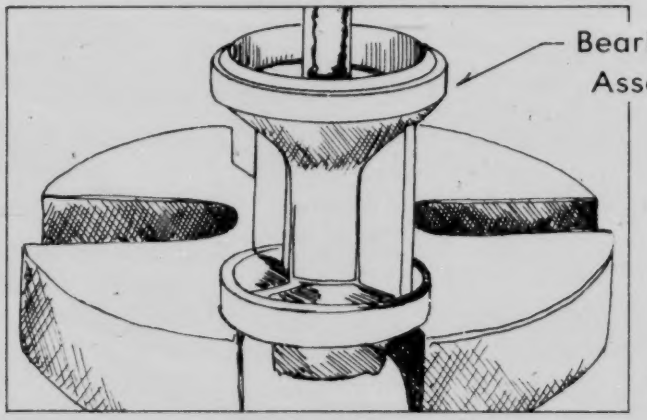


FIGURE 7

B. Disassemble propeller shaft and shift shaft

1. Detach retaining ring from dog clutch (Figure 8)

(NOTE: Do not overstretch or ring will lose its shape and tension.)

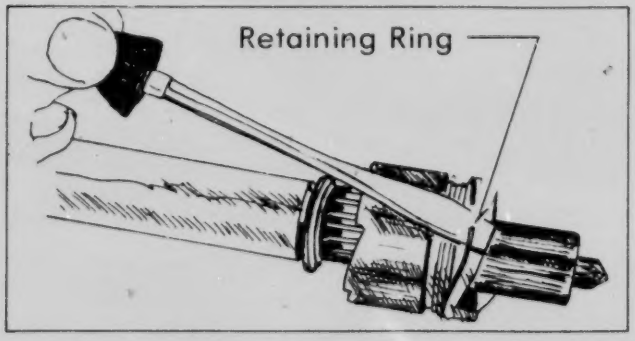


FIGURE 8

JOB SHEET #1

2. Remove dog clutch from propeller shaft (Figure 9)

(NOTE: Do not lose cross pin and spring.)

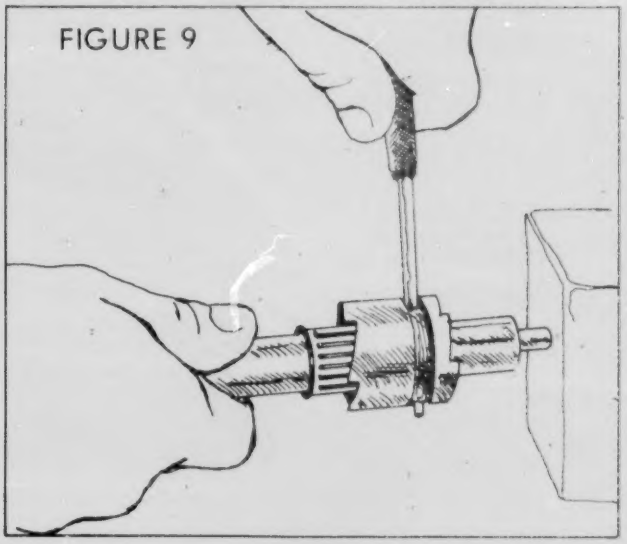


FIGURE 9

3. Remove lower reverse locking cam from shift shaft bushing

4. Remove shift shaft bushing (Figure 10)

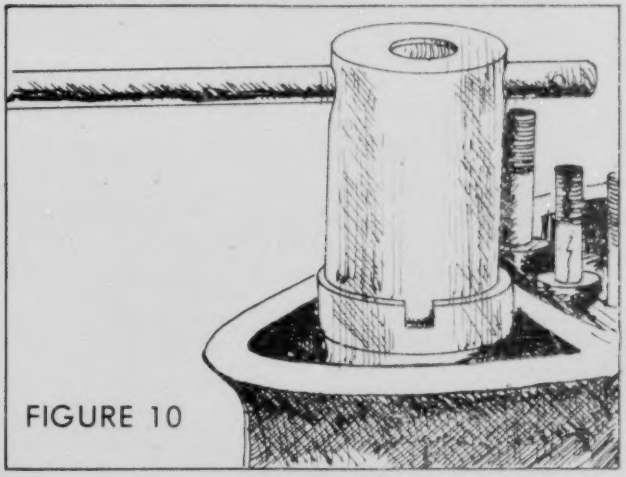


FIGURE 10

5. Remove shift shaft from gearcase assembly

(NOTE: Do not lose shifting cam.)

JOB SHEET #1

C. Remove drive shaft

1. Place drive shaft in vise as close to gear assembly as possible

2. Bend back tab washer and remove screw from drive shaft pinion gear (Figure 11)

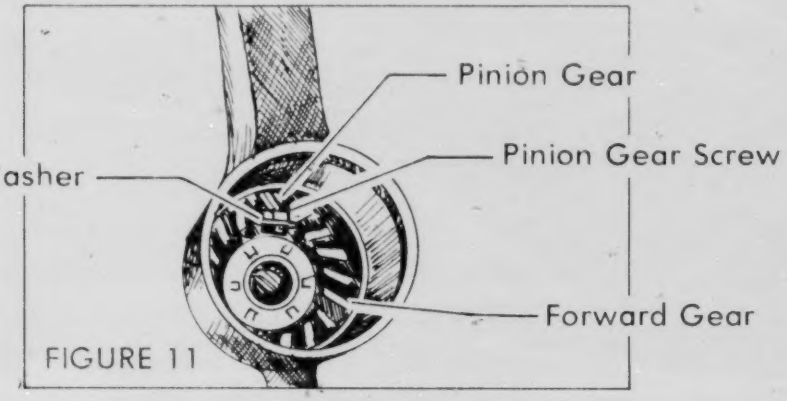


FIGURE 11

3. Remove drive shaft (Figure 12)

(NOTE: Some drive shafts have shims under the ball bearing. Remember to reinstall these shims during reassembly.)

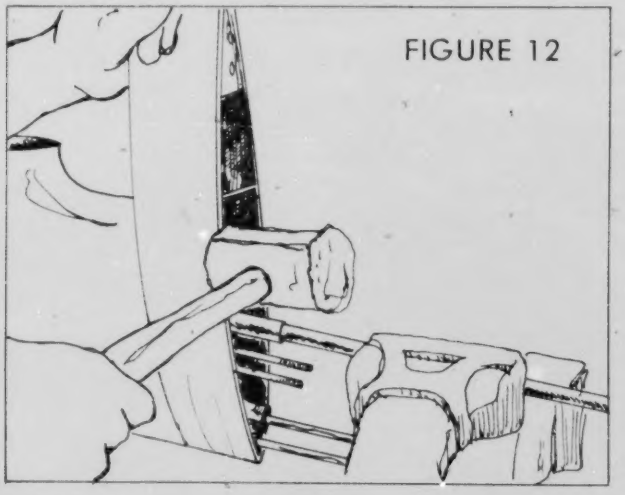


FIGURE 12

4. Remove foward gear and bearing assembly

D. Reassemble mechanical gearcase by reversing disassembly procedures A, B, and C

JOB SHEET #1

E. Service mechanical gearcase

1. Pressure test gearcase (Figure 13)

(NOTE: Gearcase should hold about 16-18 pounds pressure. Check service manual specifications.)

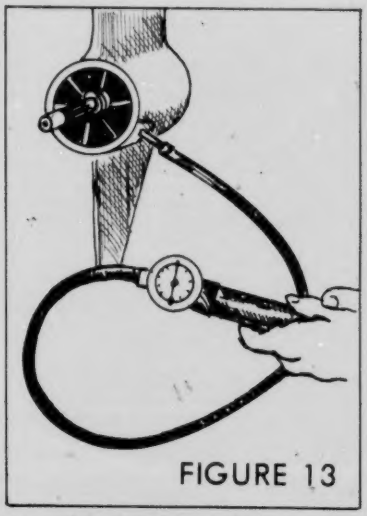
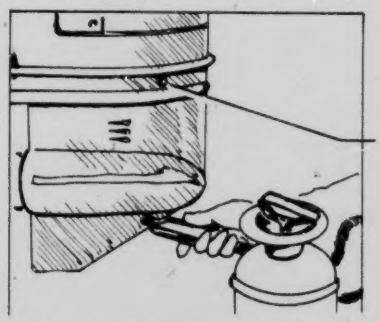


FIGURE 13

2. Fill gearcase with lubricant (Figure 14)



(NOTE: Replace vent plugs before removing filler hose.)

FIGURE 14

MECHANICAL GEARCASE
UNIT VII

JOB SHEET #2--DISASSEMBLE, INSPECT, REASSEMBLE, AND SERVICE A TWO-PIECE MECHANICAL GEARCASE

I. Tools and materials

A. Parts tray

B. Appropriate service manual

C. Bench vise

D. Two blocks of wood

E. Recommended gear lubricant

F. Gearcase leak tester

II. Procedure

A. Disassemble gearcase

1. Drain lubricant from gearcase by removing grease filler hole screw and air vent hole screw (Figure 1)

(NOTE: Do not lose washer.)

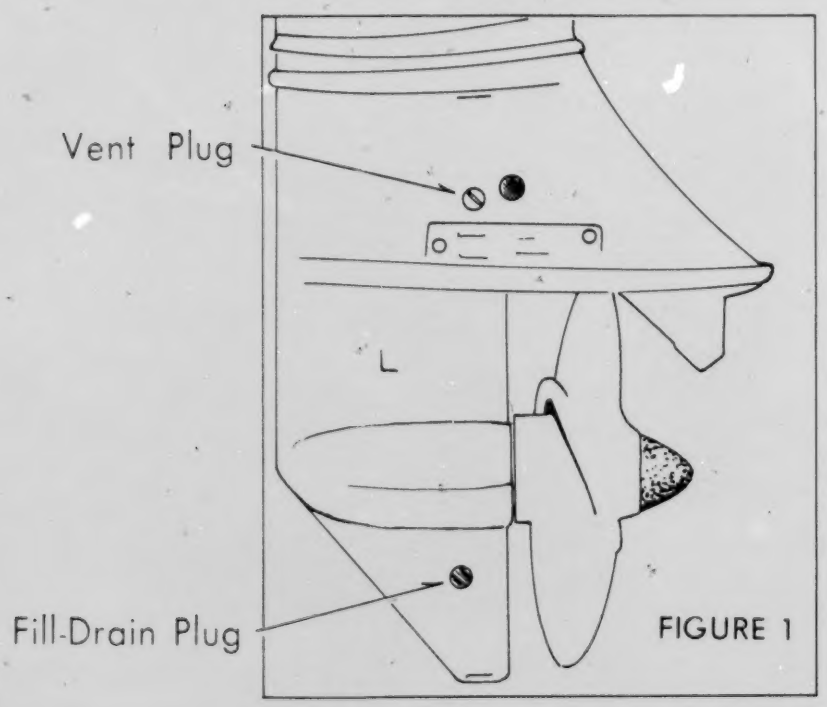


FIGURE 1

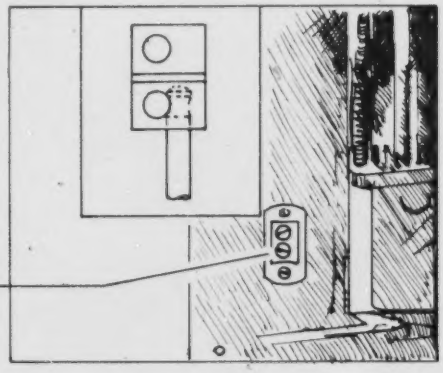
JOB SHEET #2

2. Replace washer and screws after draining

3. Remove propeller

4. Remove exhaust housing cover plate to expose shift rod connector (Figure 2)

FIGURE 2



5. Remove lower connector screw (Figure 2)

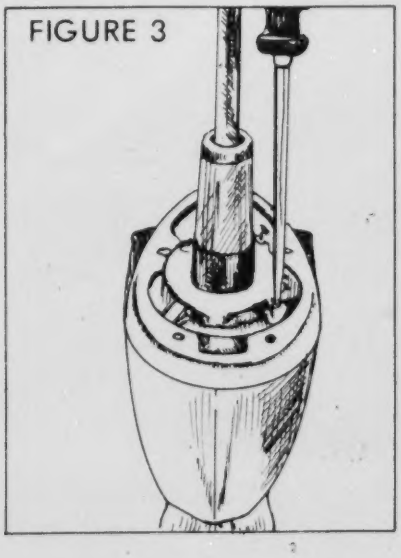
(NOTE: This is not used on all models.)

6. Remove gearcase assembly from exhaust housing

7. Set gearcase in vise in upright position with skeg held between blocks of wood

8. Remove screws attaching water pump to gearcase (Figure 3)

FIGURE 3



JOB SHEET #2

9. Lift water pump from gearcase (Figure 4)

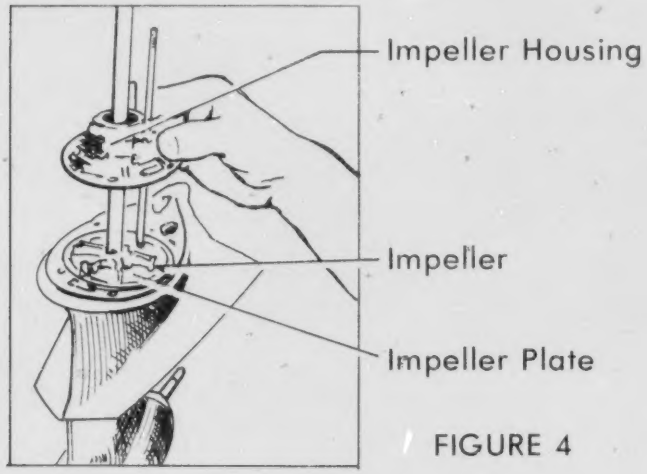
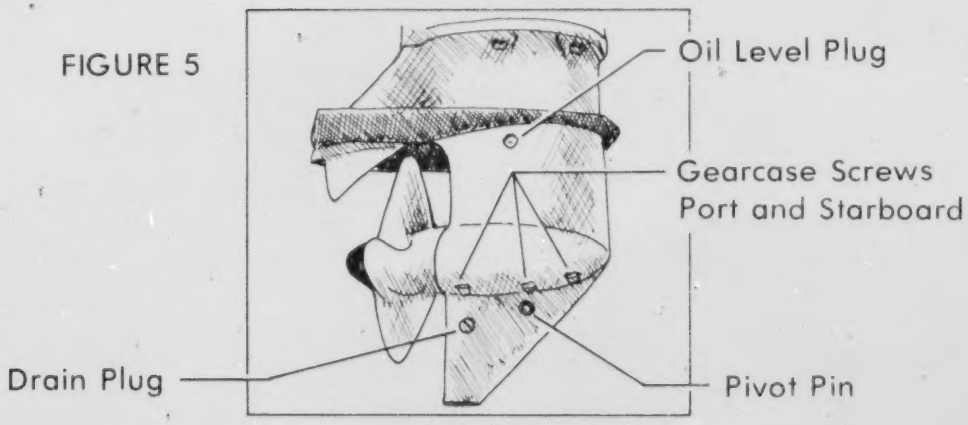


FIGURE 4

10. Turn the gearcase upside down and hold it in position by clamping the drive shaft in the vise

11. Remove shift rod pivot pin and screws attaching gearcase halves (Figure 5)

FIGURE 5



12. Separate gearcase halves (Figure 6)

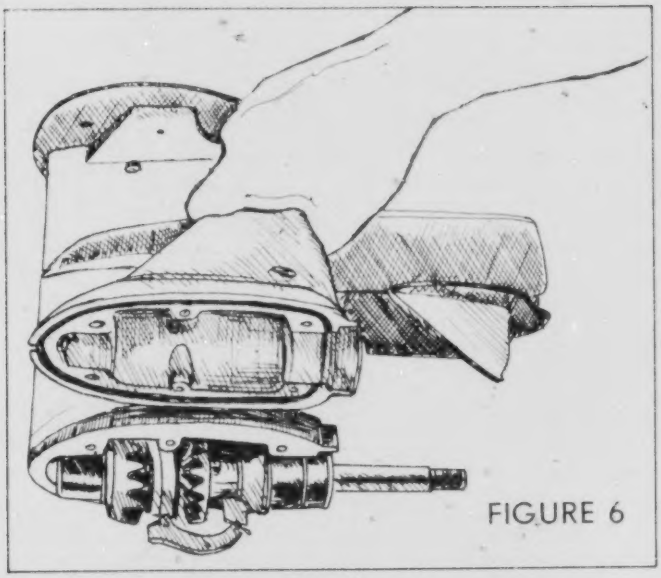


FIGURE 6

13. Swing shifter lever and cradle out of way (Figure 7)

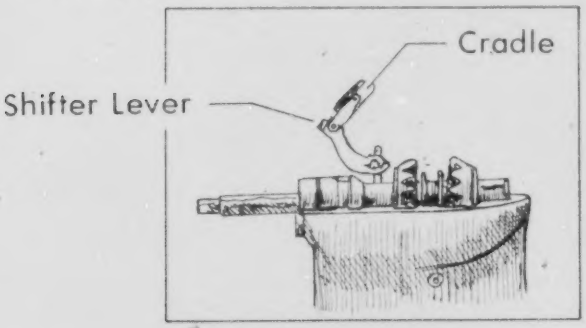


FIGURE 7

14. Lift propeller shaft with all components from the gearcase as an assembly

15. Disassemble components from propeller shaft

16. Remove pinion gear and thrust washer

17. Remove the gearcase from the drive shaft

18. Remove the drive shaft from the vise

B. Inspect gearcase

1. Check the drive shaft, propeller shaft, and shift seals for damage

JOB SHEET #2

2. Remove the lower-to-upper gearcase seal and oil retainer housing oil ring

(NOTE: Always replace such seals with new ones when reassembling.)

3. Check the propeller shaft gears and shift dog clutch for wear

(NOTE: Never attempt to mesh an old worn gear with a new gear; replace both gears in such a case.)

4. Check bearings and bushings in the gearcase

(NOTE: Some bushings are not of the replaceable type; gearcase will have to be replaced.)

5. Inspect water tube and water intake screen for obstruction or kinks which may restrict water flow

C. Reassemble gearcase by reversing disassembly procedure under section A

D. Service gearcase

1. Pressure test gearcase (Figure 8)

(NOTE: Gearcase should hold about 16-18 pounds pressure. Check service manual specifications.)

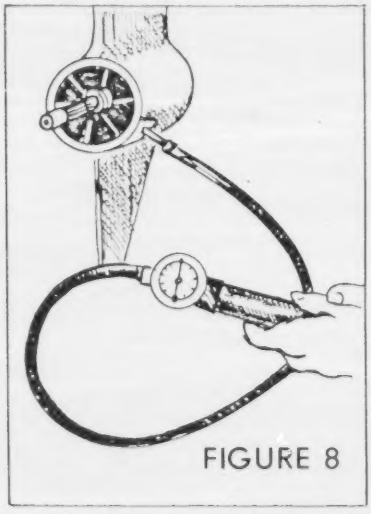


FIGURE 8

JOB SHEET #2

2. Fill gearcase with lubricant (Figure 9)

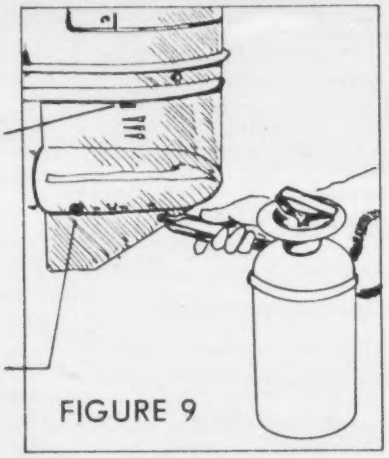


FIGURE 9

(NOTE: Replace vent plugs before removing lubricant filler hose.)

MECHANICAL GEARCASE
UNIT VII

NAME_____

TEST

1. Match the terms on the right to the correct definitions.

_____a. Gear on the end of the drive shaft

_____b. Thin sheets used as spacers between two parts

_____c. Bronze or hardened steel washer placed between two moving parts

_____d. Motion between a driving part and a driven part which does not cause motion of the driven part

_____e. Housing containing the parts of the transmission

_____f. Mating collars or flanges with projecting lugs or fingers which interlock when engaged

1. Dog clutch
2. Backlash
3. Pinion gear
4. Gearcase
5. Shims
6. Thrust washer

2. Identify the parts of the mechanical gearcase.

a.

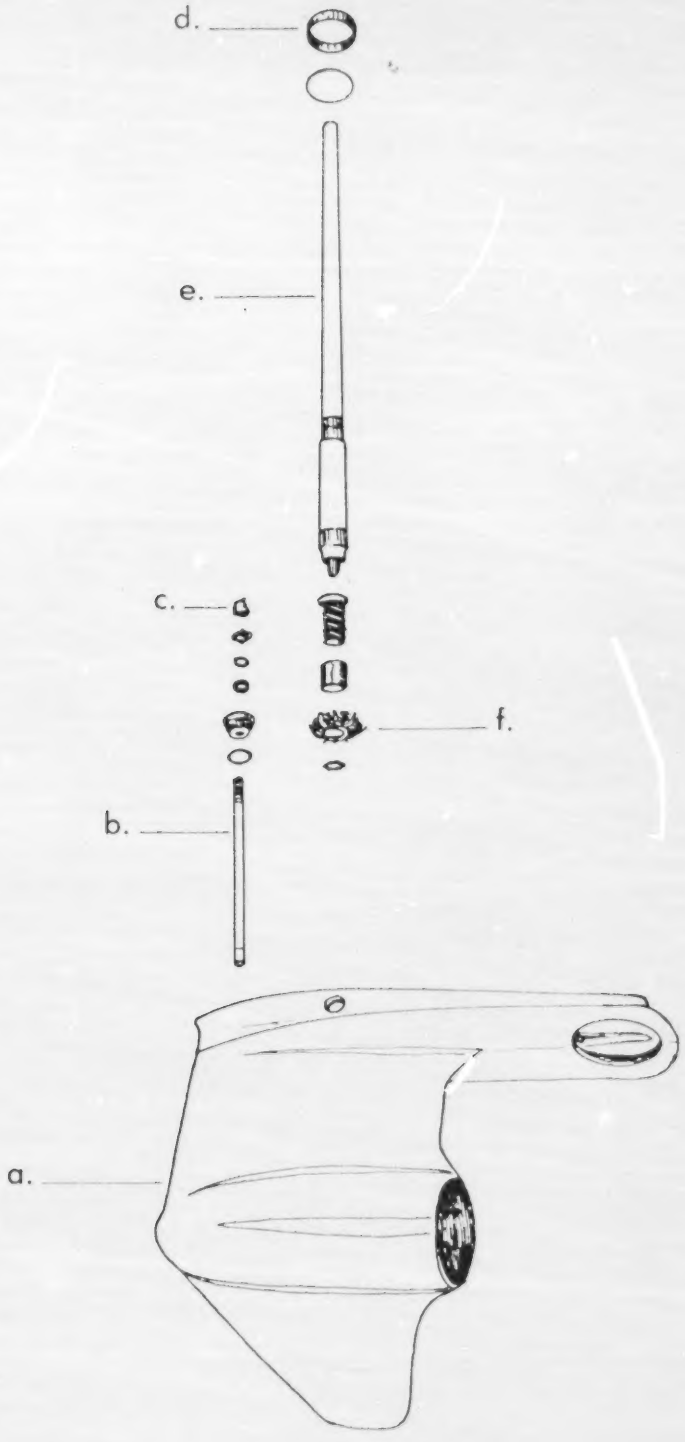
b.

c.

d.

e.

f.



2. (Continued)

g.

h.

i.

j.

k.

l.

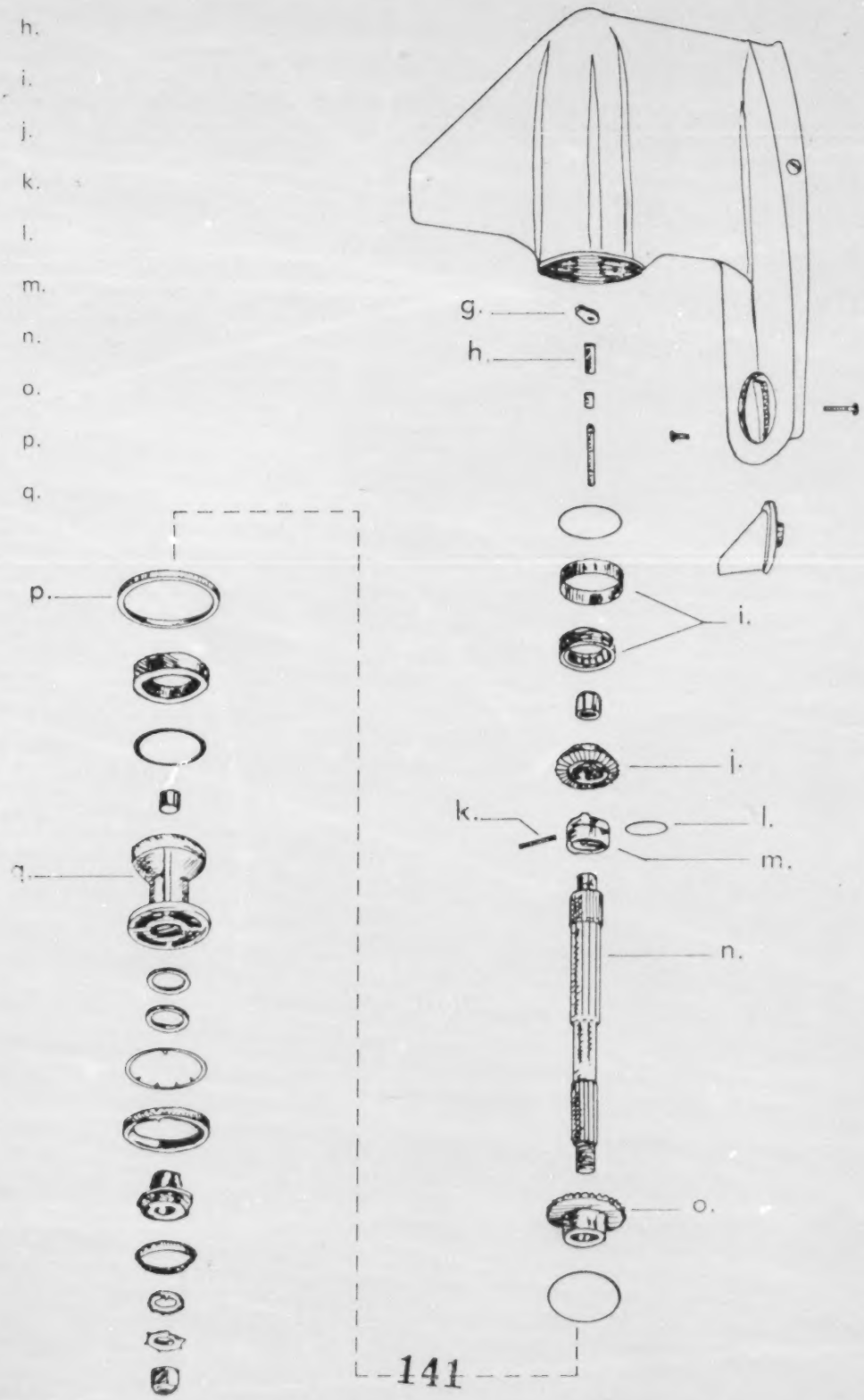
m.

n.

o.

p.

q.



3. State the purposes of the main parts of the mechanical gearcase.

   a. Shafts--

   b. Gear and bearing assemblies--

   c. Seals--

4. Demonstrate the ability to:

   a. Disassemble, reassemble, and service a one-piece mechanical gearcase.

   b. Disassemble, inspect, reassemble, and service a two-piece mechanical gearcase.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

MECHANICAL GEARCASE
UNIT V

ANSWERS TO TEST

1. a. 3
   b. 5
   c. 6
   d. 2
   e. 4
   f. 1

2. a. Gearcase
   b. Shift shaft
   c. Reverse locking cam
   d. Bearing
   e. Drive shaft
   f. Pinion gear
   g. Shift cam
   h. Cam follower
   i. Tapered-roller bearing assembly
   j. Forward gear assembly
   k. Cross pin
   l. Retaining ring
   m. Dog clutch
   n. Propeller shaft
   o. Reverse gear assembly
   p. Thrust washer
   q. Bearing carrier assembly

3. a. Shafts--Transmit the power from the engine to the propeller
   b. Gear and bearing assemblies--Transform the rotary energy of the drive shaft into forward motion of the boat
   c. Seals--Retain lubrication and prevent water from entering gear housing

4. Performance skills evaluated to the satisfaction of the instructor

ELECTRICAL GEARCASE
UNIT VIII

UNIT OBJECTIVE

After completion of this unit, the student should be able to match terms associated with the electrical gearcase and identify the parts. The student should also be able to list the functions of the electrical shift solenoids and demonstrate the ability to disassemble and reassemble the electrical gearcase. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with the electrical gearcase to the correct definitions.
2. List the functions of the electrical shift solenoids.
3. Identify the parts of the electrical gearcase.
4. Demonstrate the ability to:
   a. Disassemble an electrical gearcase.
   b. Reassemble an electrical gearcase.

ELECTRICAL GEARCASE
UNIT VIII

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide student with objective sheet.

B. Provide student with information and job sheets.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Demonstrate and discuss the procedures outlined in the job sheets.

G. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Complete job sheets.

D. Complete activities assigned by instructor.

E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1--Parts of Electrical Gearcase

2. TM 2--Cutaway of Electrical Gearcase

D. Job sheets

1. Job Sheet #1--Disassemble an Electrical Gearcase

2. Job Sheet #2--Reassemble an Electrical Gearcase

E. Test

F. Answers to test

II. Reference--*Evinrude Service Manual*. Milwaukee, Wisconsin: Evinrude Motors/Outboard Marine Corp., 1971.

ELECTRICAL GEARCASE
UNIT VIII

INFORMATION SHEET

I. Terms and definitions

A. Oil pump--Creates the oil pressure which shifts gears into neutral and reverse

B. Truarc ring--Split ring that is snapped into a groove, used to hold bearing, thrust washers, and gears in place

(NOTE: This is sometimes called a snap ring.)

C. Ball check valve--Part of oil pump that directs hydraulic pressure to the correct passage

D. Shift piston--Part of oil pump that places dog clutch in the selected gear position

II. Functions of electrical shift solenoids

A. Operate the casing and shift rod up and down movement

B. Operate the ball check valves

III. Parts of electrical gearcase (Transparencies 1 and 2)

A. Upper and lower solenoids

B. Spacer

C. Shift lead

D. Casing

E. Shift rod

F. Plungers

G. Wave washer

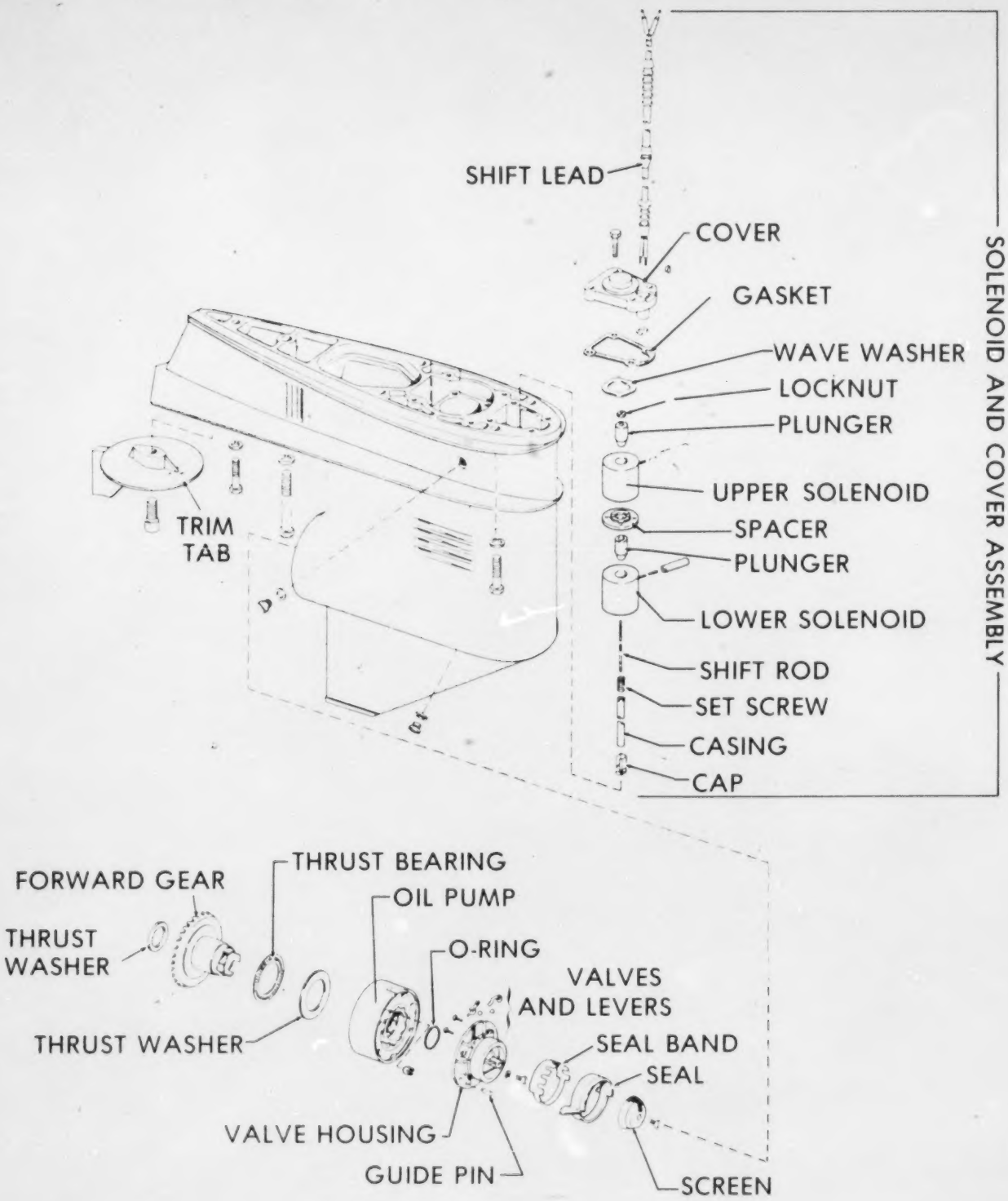
H. Oil pump

I. Seal band

J. Seal

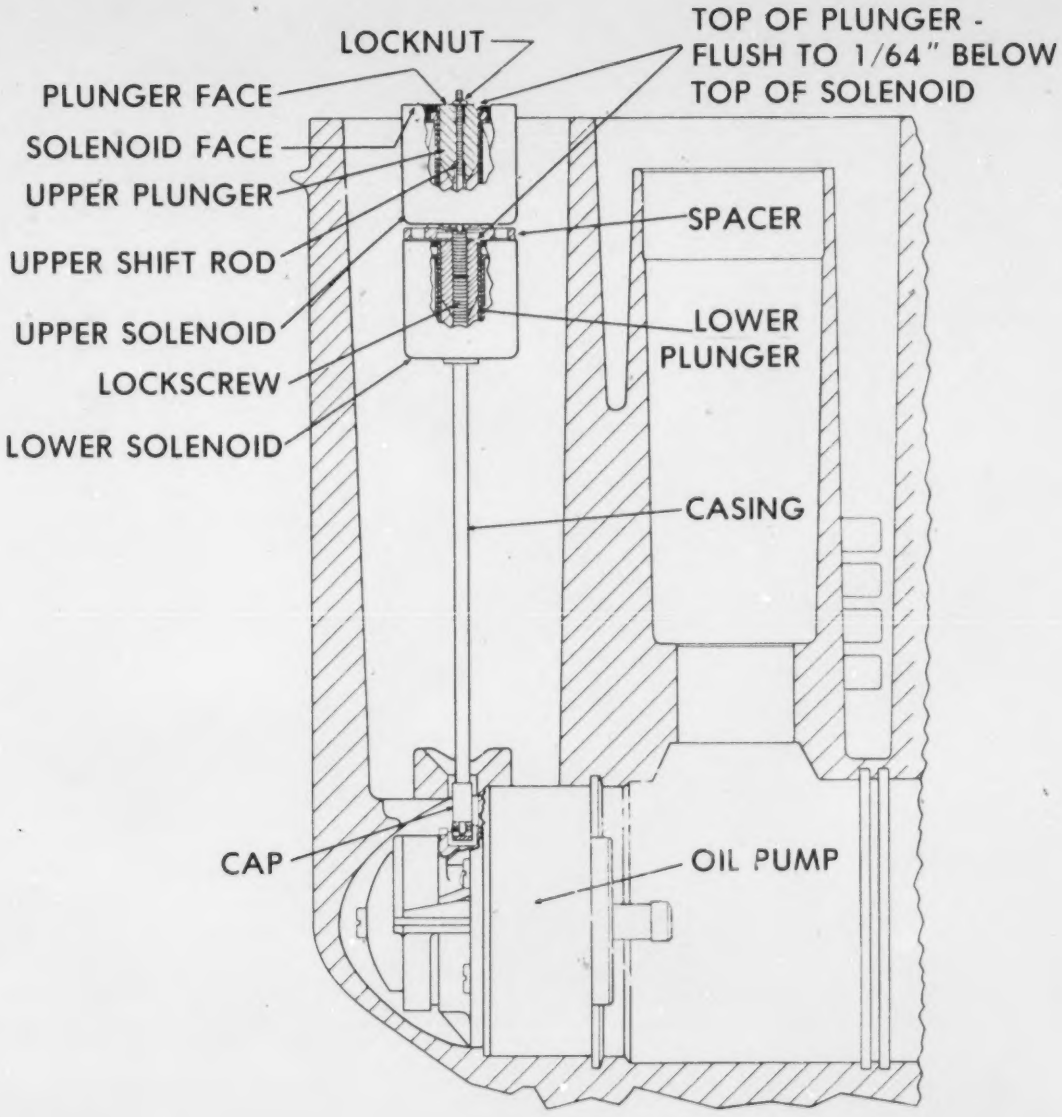
K. Screen

PARTS OF AN ELECTRICAL GEARCASE



TM 1

CUTAWAY OF AN ELECTRICAL GEARCASE



ELECTRICAL GEARCASE
UNIT VIII

JOB SHEET #1--DISASSEMBLE AN ELECTRICAL GEARCASE

I. Tools and materials

A. Hand tool assortment

B. Parts tray

C. Appropriate service manual

D. Slide hammers

E. No. 7 Truarc pliers

F. Two 1/4" all thread slide hammer rods

II. Procedure

A. Disconnect battery

B. Drain lubricant from gearcase

C. Remove propeller

D. Disconnect shift cable from motor cable (Figure 1)

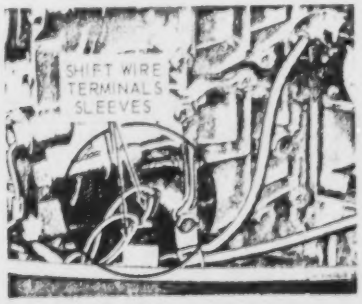


FIGURE 1

E. Apply oil or liquid soap to cable sleeve

(NOTE: This is done to ease its passage through hole in exhaust housing adapter when removing gearcase.)

F. Remove gearcase

G. Place gearcase in a suitable holding fixture

JOB SHEET #1

H. Remove water pump and bearing housing (Figure 2)

FIGURE 2

I. Remove screw holding solenoid cover and wave washer (Figure 3)

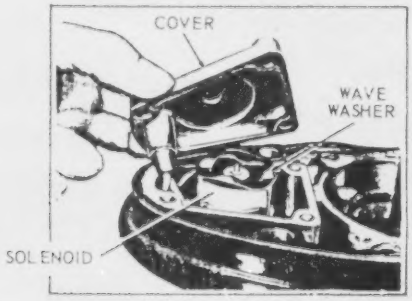


FIGURE 3

J. Remove solenoids (Figure 3)

K. Remove bearing housing screws

L. Using a slide hammer with a hooked end, pull bearing housing from gearcase (Figure 4)

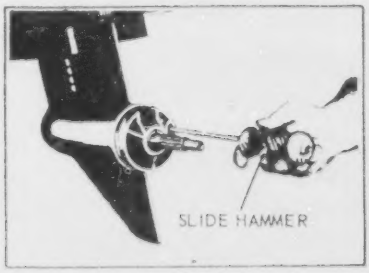


FIGURE 4

JOB SHEET #1

M. Remove Truarc rings with Truarc pliers (Figure 5)

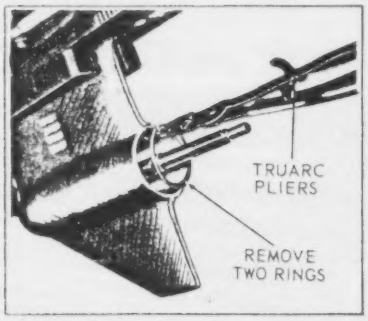


FIGURE 5

N. Remove propeller shaft assembly (Figure 6)

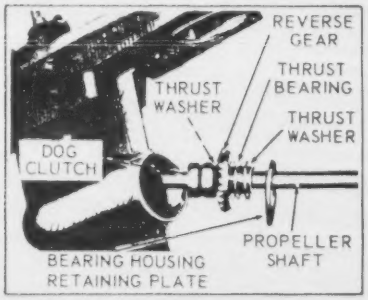


FIGURE 6

O. Remove pinion gear locknut (Figure 7)

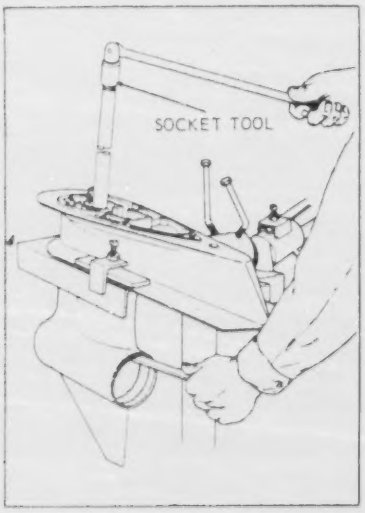


FIGURE 7

P. Remove pinion gear and pull drive shaft out of the gearcase

Q. Remove oil pump from gearcase using two slide hammers and 1/4" all thread slide hammer rods (Figure 8)

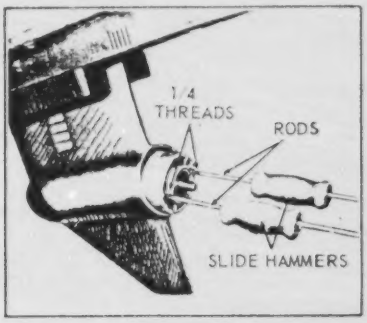


FIGURE 8

R. Disassemble oil pump

1. Remove rubber oil seal, band, screw, and screen from front of oil pump (Figure 9)

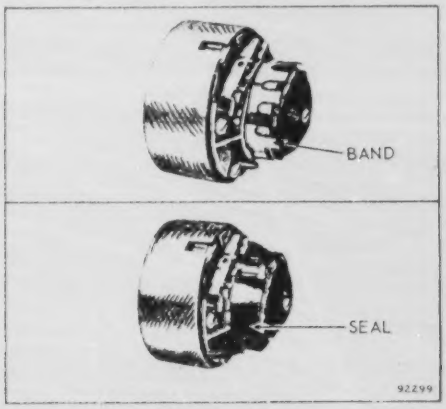


FIGURE 9

2. Remove screws and valve housing from front of pump (Figure 10)

FIGURE 10

JOB SHEET #1

3. Remove reverse valve lever (Figure 11)

(NOTE: This is the lever with the hole in it.)

FIGURE 11

4. Remove guide pin, valve, arm, and ball check valves (Figure 12)

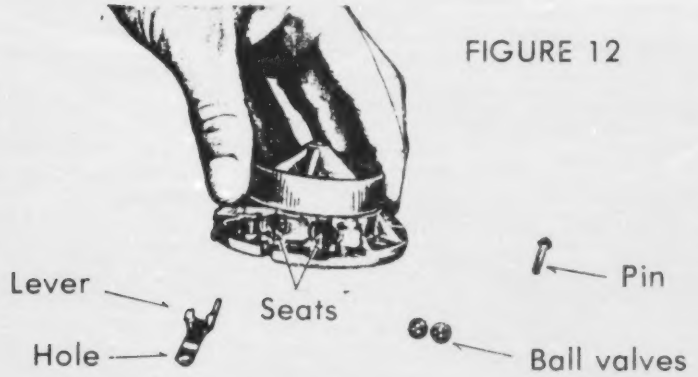


FIGURE 12

S. Clean and inspect all parts for reassembly

ELECTRICAL GEARCASE
UNIT VIII

JOB SHEET #2--REASSEMBLE AN ELECTRICAL GEARCASE

I. Tools and materials

A. Hand tool assortment

B. Parts tray

C. Appropriate service manual

D. Two 1/4" all thread guide rods

E. Appropriate lubricant

F. Pressure gauge

II. Procedure

A. Assemble oil pump

1. Install ball check valves and reattach the valve lever with guide pin

2. Lubricate pump gears

(NOTE: Use lubricant recommended in service manual for your make and model of gearcase.)

3. Install oil pump gears

4. Install valve housing on pump and align the slots on pump and valve housing

5. Install forward gear, thrust bearing, and thrust washers (Figure 1)

(NOTE: Surfaces of pump gears and pump housing must be parallel when forward gear, thrust bearing, and washers are installed.)

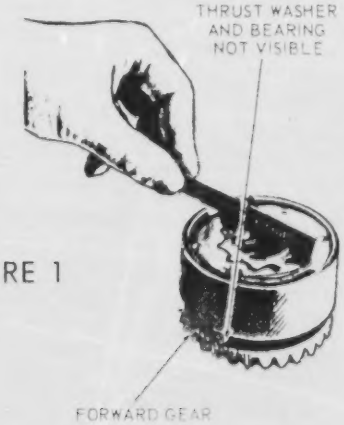


FIGURE 1

6. Install and torque screws as specified in service manual

7. Install screen, band, and rubber oil seal

8. Install shift piston in pump

B. Install oil pump using slide hammer

(NOTE: Be sure to align pin in front of pump assembly with hole in gearcase housing.)

C. Install forward gear, thrust bearing, and thrust washers

D. Install drive shaft in gearcase and secure pinion gear to drive shaft with pinion nut

(NOTE: Check service manual for correct torque.)

E. Install propeller shaft assembly

F. Install bearing housing retainer plate in the gearcase

G. Install two Truarc retaining rings

H. Thread guide pins into the retainer plate (Figure 2)

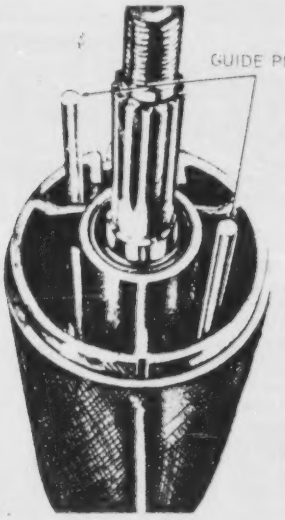


FIGURE 2

I. Install propeller shaft bearing housing and screws

(NOTE: Check service manual for correct torque.)

JOB SHEET #2

J. Install thrust bearing, thrust washers, and shims (Figure 3)

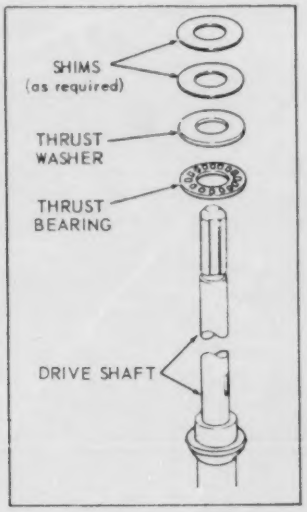


FIGURE 3

K. Adjust and install solenoid

1. Adjust the solenoid plungers (Figure 4)

(NOTE: Consult service manual for adjustment specifica

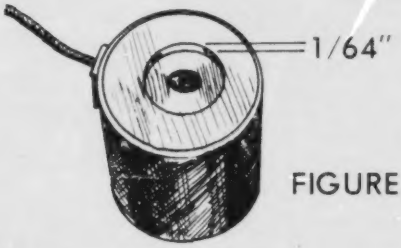


FIGURE 4

2. Tighten lower solenoid locknut and upper solenoid locknut

(NOTE: Consult service manual for torque specifications.)

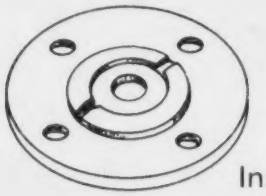
3. Install lower solenoid and casing

(NOTE: Be sure the solenoid seats properly in the gearcase housing.)

JOB SHEET #2

4. Install solenoid spacer (Figure 5)

FIGURE 5



Install up as illustrated

5. Install upper solenoid assembly with plunger and shift rod assembly into gearcase (Figure 6)

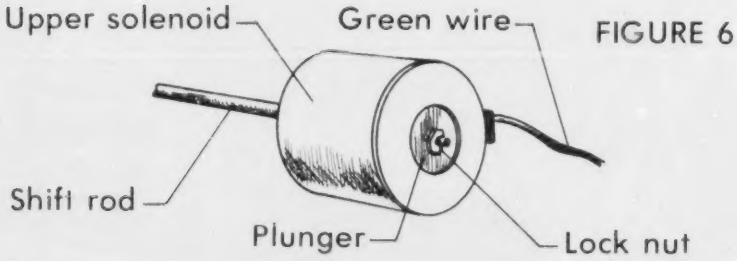


FIGURE 6

L. Install wave washer, solenoid cover, gasket, and screws

M. Install water pump

N. Pressure test gearcase

O. Install gearcase on exhaust housing

ELECTRICAL GEARCASE
UNIT VIII

NAME_____

TEST

1. Match the terms on the right to the correct definitions.

_____a. Part of oil pump that directs hydraulic pressure to the correct passage

_____b. Split ring that is snapped into a groove, used to hold bearing, thrust washers, and gears in place

_____c. Creates the oil pressure which shifts gears into neutral and reverse

_____d. Part of oil pump that places dog clutch in the selected gear position

1. Oil pump
2. Truarc ring
3. Ball check valve
4. Shift piston

2. List the functions of the electrical shift solenoids.

a.

b.

3. Identify the parts of the electrical gearcase.

a.

b.

c.

d.

e.

f.

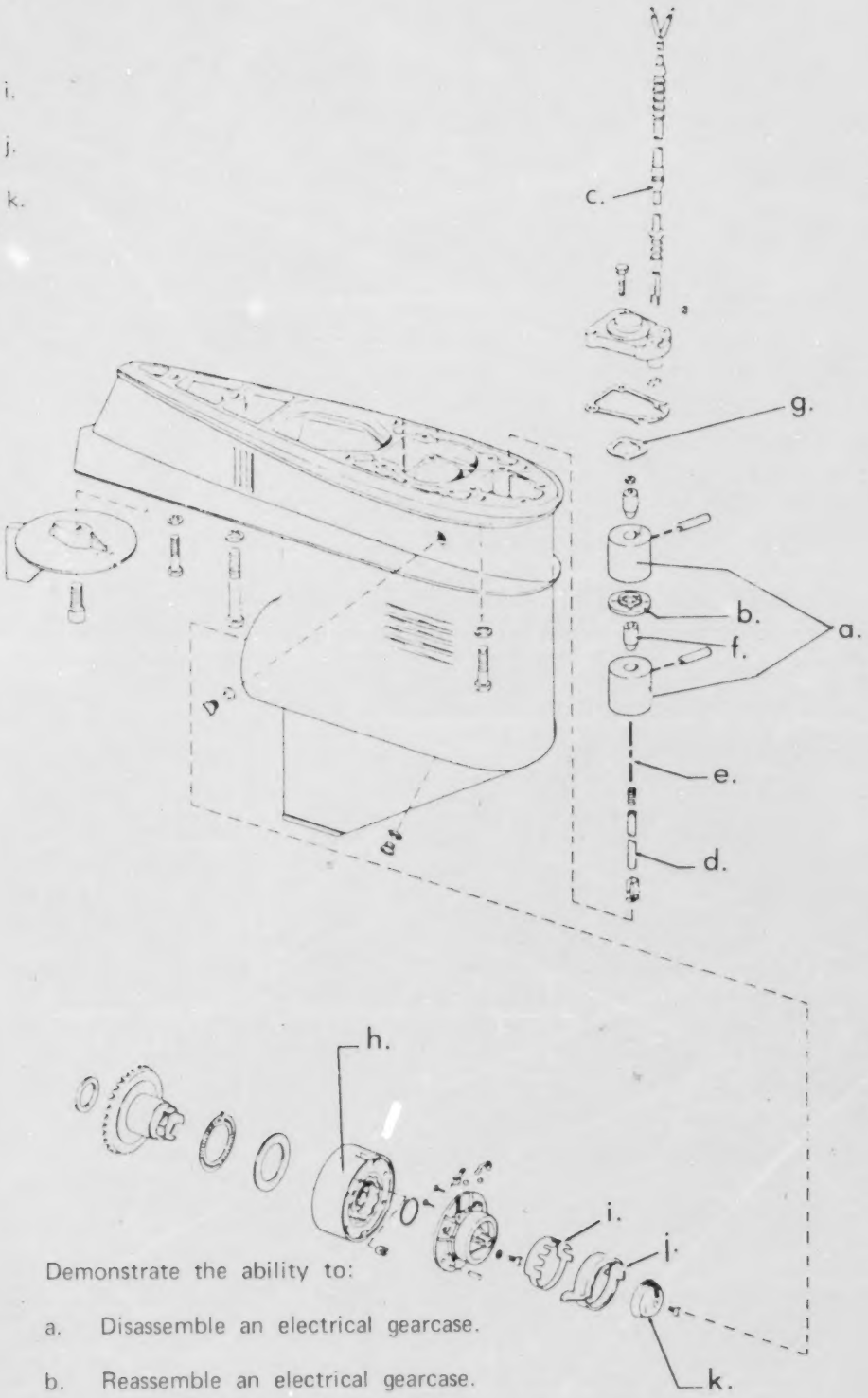
g.

h.

i.

j.

k.



4. Demonstrate the ability to:

   a. Disassemble an electrical gearcase.

   b. Reassemble an electrical gearcase.

(NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

ELECTRICAL GEARCASE
UNIT VIII

ANSWERS TO TEST

1. a. 3
   b. 2
   c. 1
   d. 4
2. a. Operate the casing and shift rod up and down movement
   b. Operate the ball check valves
3. a. Upper and lower solenoids
   b. Spacer
   c. Shift lead
   d. Casing
   e. Shift rod
   f. Plungers
   g. Wave washer
   h. Oil pump
   i. Seal band
   j. Seal
   k. Screen
4. Performance skills evaluated to the satisfaction of the instructor

FUEL SUPPLY SYSTEMS
UNIT IX

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify the parts of the outboard pressurized fuel system. The student should also be able to disassemble, reassemble, and service a fuel system. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit the student should be able to:

1. Match terms associated with the outboard fuel system to the correct definitions.
2. Identify the parts of the outboard pressurized fuel system.
3. Identify the parts of the primer bulb of an outboard vacuum fuel system.
4. Identify the parts of the outboard vacuum fuel system.
5. List five fuel system problems which can cause an outboard to perform improperly.
6. List three engine problems from improper fuel supply.
7. Demonstrate the ability to:
   a. Disassemble, service, and reassemble a pressurized fuel system.
   b. Disassemble, service, and reassemble a vacuum fuel system.

FUEL SUPPLY SYSTEM
UNIT IX

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide student with objective sheet.

B. Provide student with information and job sheets.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Demonstrate and discuss the procedures outlined in the job sheets.

G. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Complete job sheets.

D. Study related assignments given by the instructor.

E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1--Parts of the Outboard Pressurized Fuel System
2. TM 2--Parts of the Primer Bulb
3. TM 3--Parts of the Outboard Vacuum Fuel System

D. Job Sheets

1. Job Sheet #1--Disassemble, Service, and Reassemble a Pressurized Fuel System

2. Job Sheet #2--Disassemble, Service, and Reassemble a Vacuum Fuel System

E. Test

F. Answers to test

II. References:

A. *Mercury Marine Service Manual.* 1966-1976. Fond du Lac, Wisconsin: Mercury Marine Outboard/Brunswick Corp.

B. *Outboard Motor Service Manual.* 6th ed. Vol. 2. Kansas City, Missouri: Abos Marine Publication Division/Intertec Publishing Corp., 1973.

C. *Johnson Outboard Motor Service Manual.* Waukegan, Illinois: Outboard Marine Corp., 1975.

FUEL SUPPLY SYSTEMS
UNIT IX

INFORMATION SHEET

I. Terms and definitions

A. Fuel pump--Pump which feeds the fuel from the gas tank to the carburetor of an engine

B. Primer bulb--Simple hand squeezed pump that insures fuel in the carburetor for starting the engine

(NOTE: The pumping action is necessary only when the pressure has been released from the tank. The gas tank must be vented when primer bulb is used.)

C. Pressure feed--Special air pressure tube connecting the fuel tank with a pressurized check valve; attached to the engine crankcase which uses the engine pressure to pressurize the gas tank

D. Vacuum feed--Type of fuel system with a special vacuum pump which is attached to the engine crankcase and operated by crankcase pressure

(NOTE: Gas tank must be vented.)

E. Check valve--Valve which allows passage of fuel in one direction only

II. Parts of the outboard pressurized fuel system (Transparency 1)

A. Fuel line

B. Priming pump or primer bulb

C. Fuel pick-up tube

D. Pressure relief valve

E. Air line

F. Pressurized crankcase valve

G. Twist connector

III. Parts of the primer bulb (Transparency 2)

A. Clamps

INFORMATION SHEET

B. Check valve assembly

C. Primer bulb

D. Check valve body

IV. Parts of the outboard vacuum fuel system (Transparency 3)

A. Primer bulb

B. Housing assembly (fuel connector)

C. Vent assembly

D. Fuel line

V. Fuel system problems causing improper performance

A. Inadequate air vent in fuel tank

B. Inadequate fuel line size

C. Damaged or leaking fuel line

D. Clogged or too small filters

E. Faulty fuel pump

VI. Engine problems from improper fuel supply

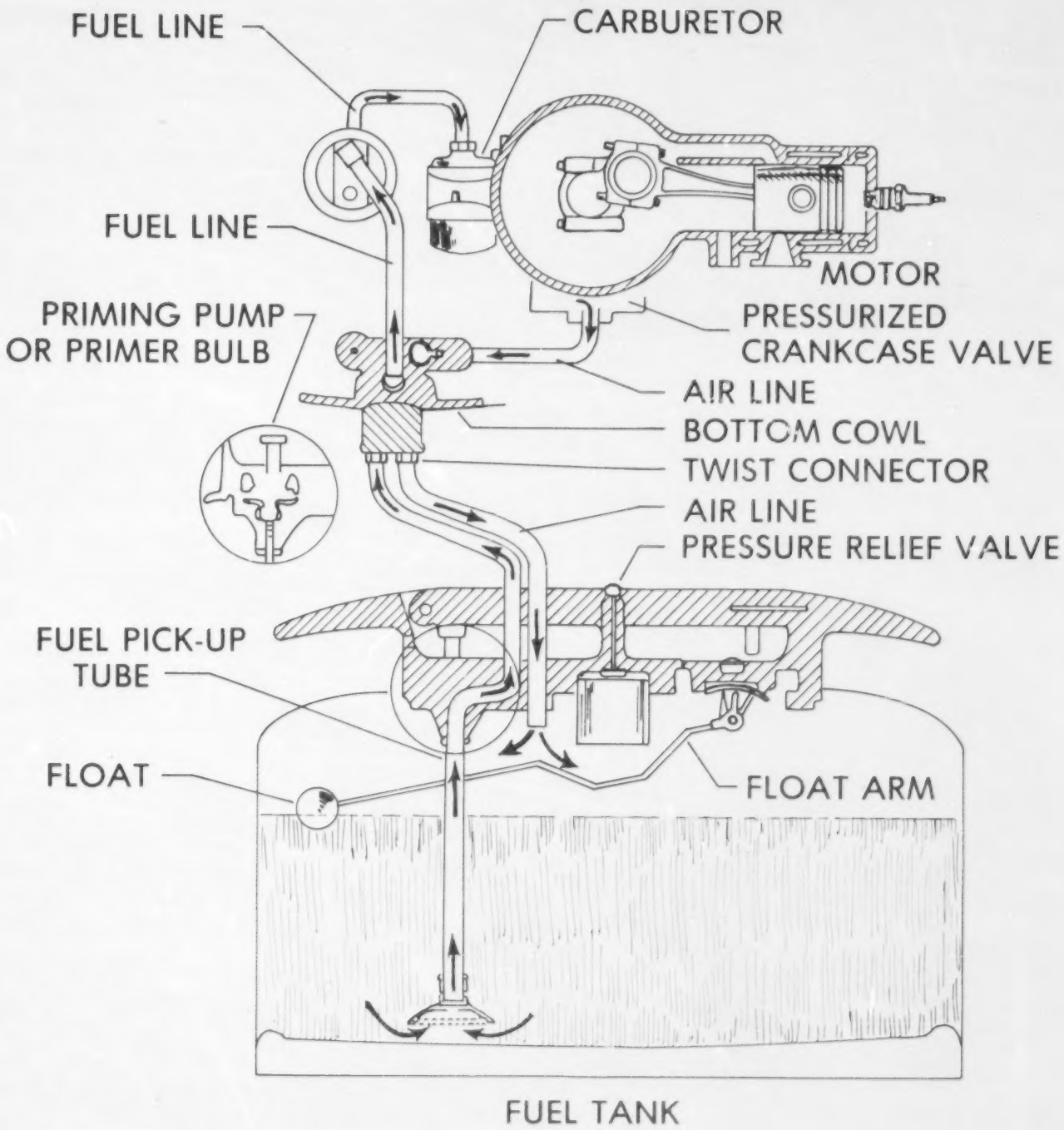
A. Motor run lean

(NOTE: This can cause excessive heat build up in the engine.)

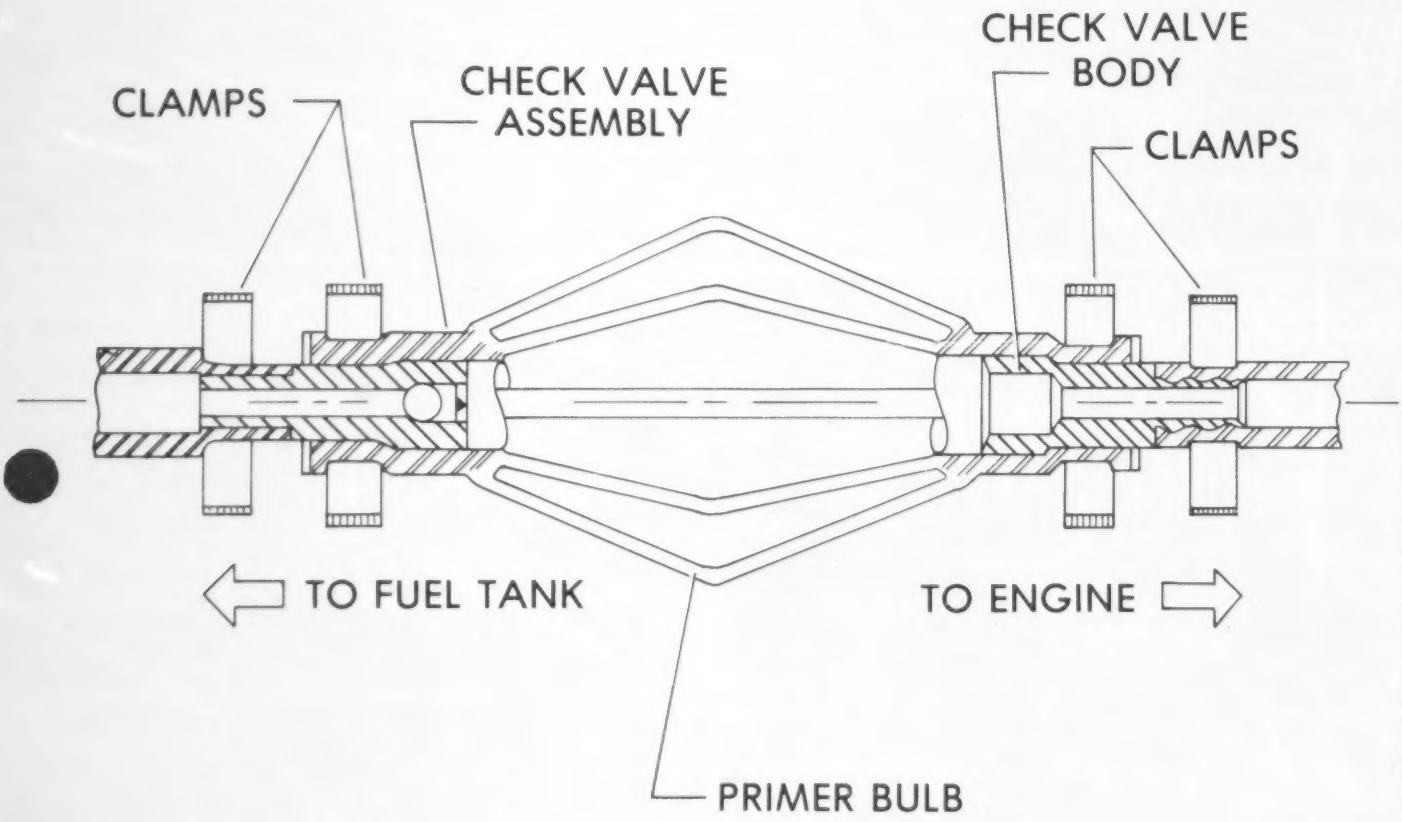
B. Loss of RPM

C. Piston and cylinder scoring

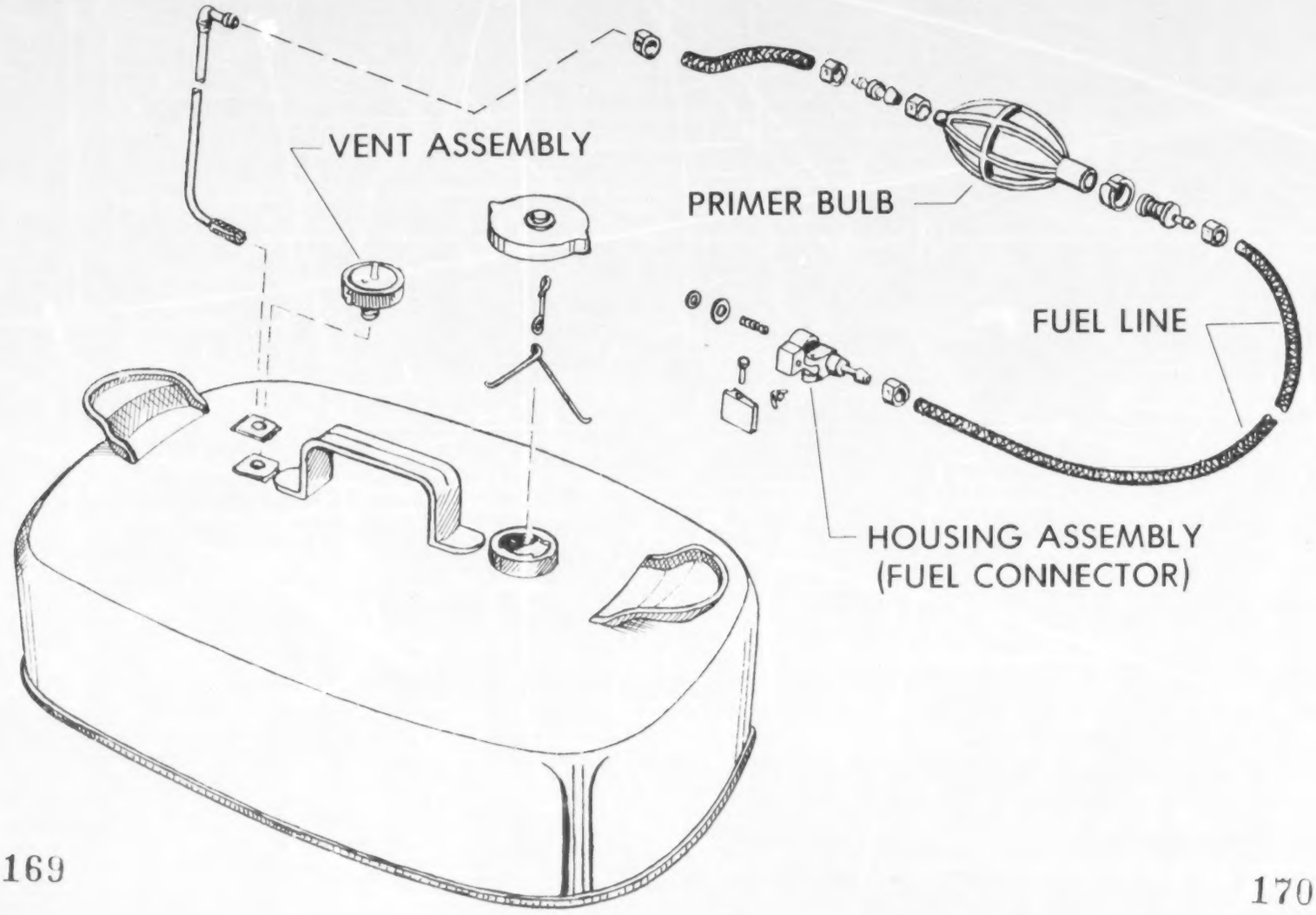
PARTS OF THE OUTBOARD PRESSURIZED FUEL SYSTEM



PARTS OF THE PRIMER BULB



PARTS OF THE OUTBOARD VACUUM FUEL SYSTEM



FUEL SUPPLY SYSTEMS
UNIT IX

JOB SHEET #1 DISASSEMBLE, SERVICE, AND REASSEMBLE
A PRESSURIZED FUEL SYSTEM

I. Tools and materials

A. Parts tray

B. Factory service manual

C. Hand tool assortment

D. Safety glasses

II. Procedure

A. Disassemble pressurized fuel tank

1. Remove screws and gasket and lift entire handle assembly carefully out of tank

(NOTE: Do not bend float rod.)

2. Empty all gas out of gas tank

(Caution: Be sure to keep room well ventilated. Dispose of gasoline properly.)

3. Loosen coupling nut on fuel pick-up tube to free filter head

(NOTE: If filter is discolored or clogged replace filter assembly.)

4. Remove screws, gasket, and primer cover from handle assembly

(NOTE: Primer cover will have a spring pressure.)

5. Remove primer diaphragm valve and spring

(NOTE: Check primer diaphragm for any holes or stretch.)

6. Check gas tank for leaks

(NOTE: Solder all leaks with good grade of solder and flux, file smooth and repaint red. Use a flameless method of soldering.)

JOB SHEET #1

B. Reassemble system

1. Install primer cover

   (NOTE: Be sure primer diaphragm valve and spring are in proper order.)

2. Install filter head on fuel pick-up tube

   (NOTE: Start coupling nut threads one or two turns with finger to avoid danger of cross-threading.)

3. Install handle assembly back on fuel tank

   (NOTE: Be sure all joints are air tight.)

FUEL SUPPLY SYSTEMS
UNIT IX

JOB SHEET #2 DISASSEMBLE, SERVICE, AND REASSEMBLE
A VACUUM FUEL SYSTEM

I. Tools and materials

A. Parts tray

B. Factory service manual

C. Hand tool assortment

D. Safety glasses

II. Procedure

A. Disassemble vacuum fuel system

1. Remove filler cap assembly

2. Remove screws and washers from fuel tank cover

3. Remove fuel tank cover assembly

4. Remove filter and pick-up tube

(NOTE: If filter is discolored or clogged replace filter assembly.)

5. Remove fuel lines and primer bulb

(NOTE: Two different fuel lines are used: one with 7/16" diameter, the other with 1/2".)

B. Reassemble system

1. Inspect for damaged or inoperative parts

2. Install fuel lines and primer bulb

(NOTE: Apply a light coat of adhesive to outside of check valve assembly and fuel line stems. Care must be exercised not to get adhesive in stem hole or on valve face.)

3. Install filter and pick-up tube

4. Replace fuel tank cover assembly

FUEL SUPPLY SYSTEMS
UNIT IX

NAME _____

TEST

1. Match the terms on the right to the correct definitions.

_____a. Valve which allows passage of fuel in one direction only

_____b. Pump which feeds the fuel from the gas tank to the carburetor of an engine

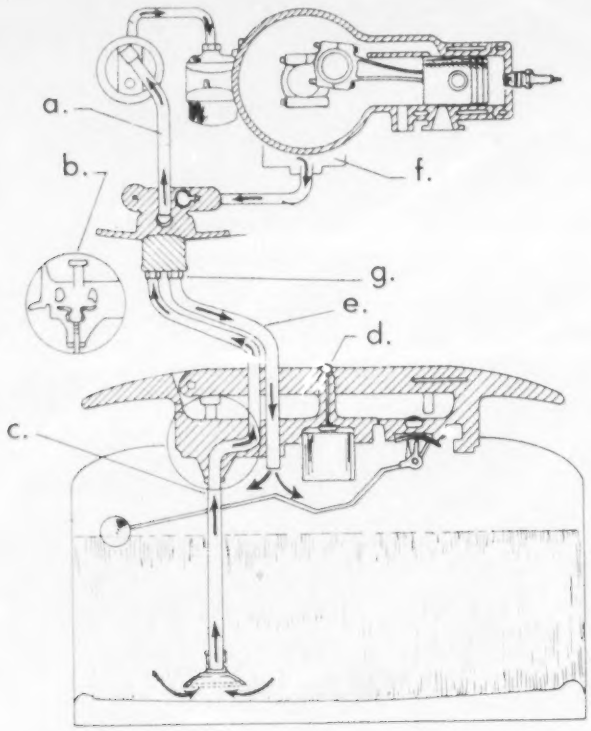
_____c. Special air pressure tube connecting the fuel tank with a pressurized check valve; attached to the engine crankcase which uses the engine pressure to pressurize the gas tank

_____d. Simple hand squeezed pump that insures fuel in the carburetor for starting the engine

_____e. Type of fuel system with a special vacuum pump which is attached to the engine crankcase and operated by crankcase pressure

1. Fuel pump
2. Primer bulb
3. Pressure feed
4. Vacuum feed
5. Check valve

2. Identify the parts of the outboard pressurized fuel system.



a. _____

b. _____

c. _____

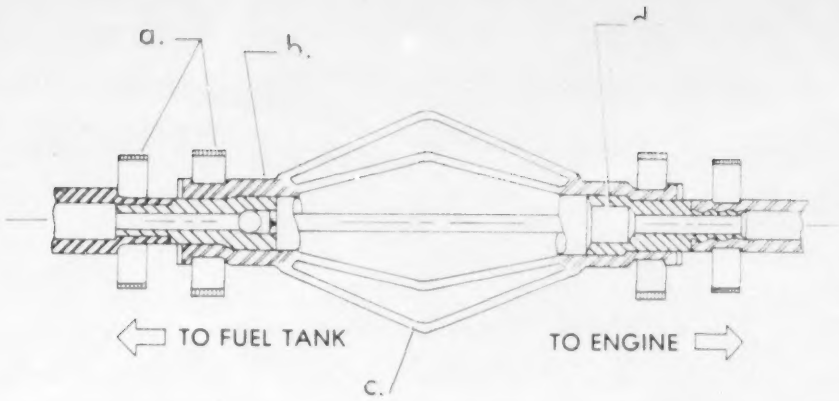
d. _____

e. _____

f. _____

g. _____

3. Identify the parts of the primer bulb of an outboard vacuum fuel system.



a. _____

b. _____

c. _____

d. _____

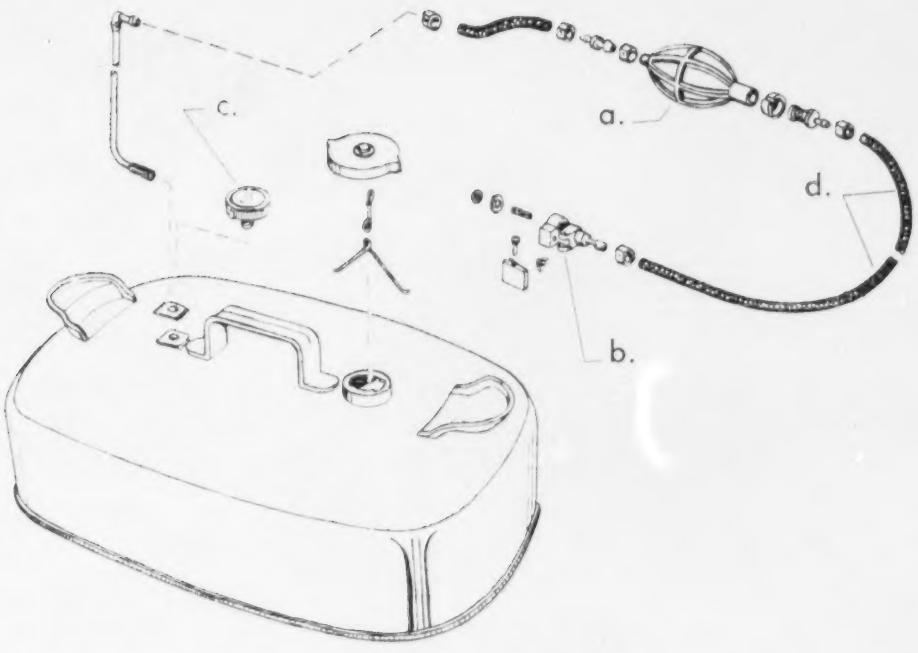
4. Identify the parts of the outboard vacuum fuel system.

a.

b.

c.

d.



5. List five fuel system problems which can cause an outboard to perform improperly.

a.

b.

c.

d.

e.

6. List three engine problems from improper fuel supply.

a.

b.

c.

7. Demonstrate the ability to:

   a. Disassemble, service, and reassemble a pressurized fuel system.

   b. Disassemble, service, and reassemble a vacuum fuel system.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

FUEL SUPPLY SYSTEMS
UNIT IX

ANSWERS TO TEST

1. a. 5
   b. 1
   c. 3
   d. 2
   e. 4
2. a. Fuel line
   b. Priming pump or primer bulb
   c. Fuel pick-up tube
   d. Pressure relief valve
   e. Air line
   f. Pressurized crankcase valve
   g. Twist connector
3. a. Clamps
   b. Check valve assembly
   c. Primer bulb
   d. Check valve body
4. a. Primer bulb
   b. Housing assembly (fuel connector)
   c. Vent assembly
   d. Fuel line
5. a. Inadequate air vent in fuel tank
   b. Inadequate fuel line size
   c. Damaged or leaking fuel line
   d. Clogged or too small filters
   e. Faulty fuel pump

6. a. Motor run lean

   b. Loss of RPM

   c. Piston and cylinder scoring

7. Performance skills evaluated to the satisfaction of the instructor.